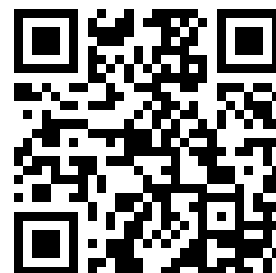

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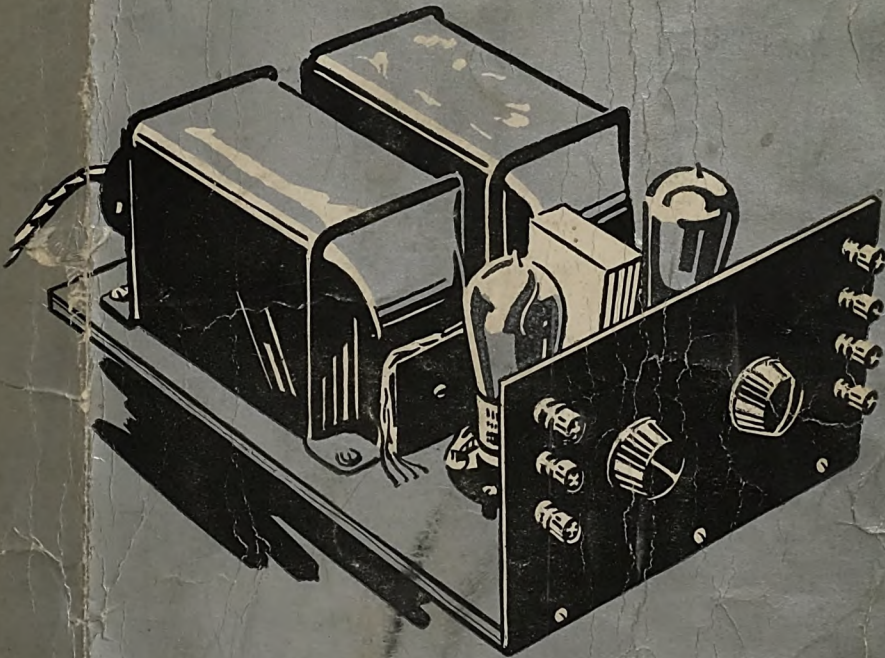
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Popular Radio

JANUARY • 1928

25¢



How to Make —

**Hi-Q Six Power Supply
1928 Browning-Drake
Victoreen Superheterodyne
New Harkness Counterfonic
Latest Push-Pull Amplifiers**

AMER TRAN - AMER TRAN - AMER TRAN - AMER TRAN

Fidelity of REPRODUCTION

AMERTRAN Presents
*a new completely
assembled audio
unit*

The
AMERTRAN
*Push-Pull Power
Amplifier*

\$60.00

*Without tubes
East of the Rockies*

The AmerTran Push-Pull Power Amplifier is a new completely assembled two-stage unit. It contains a first stage AmerTran DeLuxe followed by AmerTran Input and Output Transformers for Power Tubes. When operated from a power source supplying sufficient voltage (such as the new AmerTran A B C Hi-Power Box), the input to the speaker is almost perfect, and fidelity of reproduction is limited only by the ability of the speaker. Distortion, from tube harmonics and A C hum, is reduced to a minimum. The energy output to the speaker is increased, especially at the lower musical frequencies. This means greater clarity of tone at low or high volume.

The amplifier is easily connected to the detector of any good receiver, replacing its audio amplifier. It is equipped with four sockets, two for power tubes, and a four-prong and a five-prong socket in the first stage for either a standard amplifying tube of the UX-201 A type, or a UY-227 A C tube. Using the latter tube, the amplifier can be entirely A C operated.

AmerTran Push-Pull Amplifier as a complete unit is licensed under patents owned or controlled by the Radio Corporation of America and must be sold complete with tubes. It is built in several types, depending on the type of power tubes preferred. Type 2 AP-10 is designed for 210 tubes and type 2 AP-71 for 171 tubes. The difference is only in the Push-Pull output transformers.

This completely wired licensed AmerTran Push-Pull Amplifier is on display and demonstration at stores displaying the sign "Authorized AmerTran Dealer." Send for complete literature on this new AmerTran Unit.

AMERICAN TRANSFORMER CO.

178 Emmet Street

Newark, N. J.

"Transformer Builders for Over 26 Years"

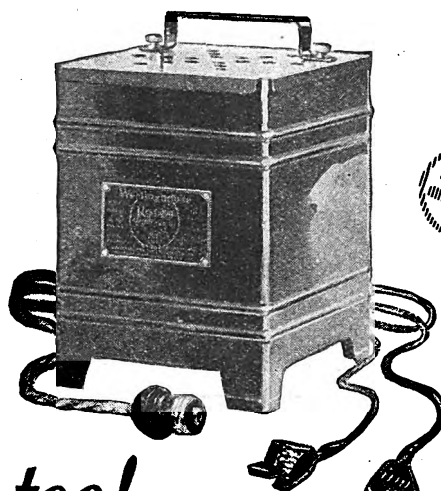
AMER TRAN - AMER TRAN - AMER TRAN -

*Sets a new standard
of quality in audio
amplification*

*Connects to the
detector of any
good set*

P0
v.13

With the Rectigon Home Charger *you can trickle charge too!*



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THE Rectigon Battery Charger gives you two charging rates—you can use it both as a “trickle” charger or for high-speed charging of wet “A” and “B” cells. Under ordinary conditions, Rectigon’s trickle rate will replace all the “A” power your set uses. Then, when unusually long hours of reception have so weakened the battery that a trickle charger can’t restore it, just shift over to Rectigon’s high rate terminal

2 Ampere Rectigon

~~\$18.00~~
now

~~\$14.00~~

5 Ampere Rectigon

~~\$28.00~~
now

~~\$24.00~~

and store away a full charge quickly.

Rectigon is made by workmen who know radio—the organization that put the first broadcast entertainment on the air. Rectigon is safe, compact, simple—has no moving parts to break and wear out—uses no liquids of any kind. Will do no harm if you absent-mindedly tune in, or if the house current fails, while charging. Get Rectigon, the *two-rate charger*, at your dealer’s.

Westinghouse Rectigon Battery Charger

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PA.

Offices in All Principal Cities / Representatives Everywhere

Tune in with KDKA—KYW—WBZ—WBZA

Rectox—for trickle charging only. Just attach the leads to your “A” battery and connect Rectox to the light line. Left permanently on charge at either ½ or ¾-ampere charging rate, it keeps your battery powerful and peppy. No messy acids, no moving parts. At your dealer’s.



Besides Rectigon and Rectox for better battery charging, Westinghouse also makes Micarta panels and tubing for better insulation, and radio testing instruments for better reception.



Popular Radio

EDITED by RAYMOND FRANCIS YATES



FOUNDED 1911

VOLUME XIII

January, 1928

NUMBER 1

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JANUARY, 1928

NUMBER 1

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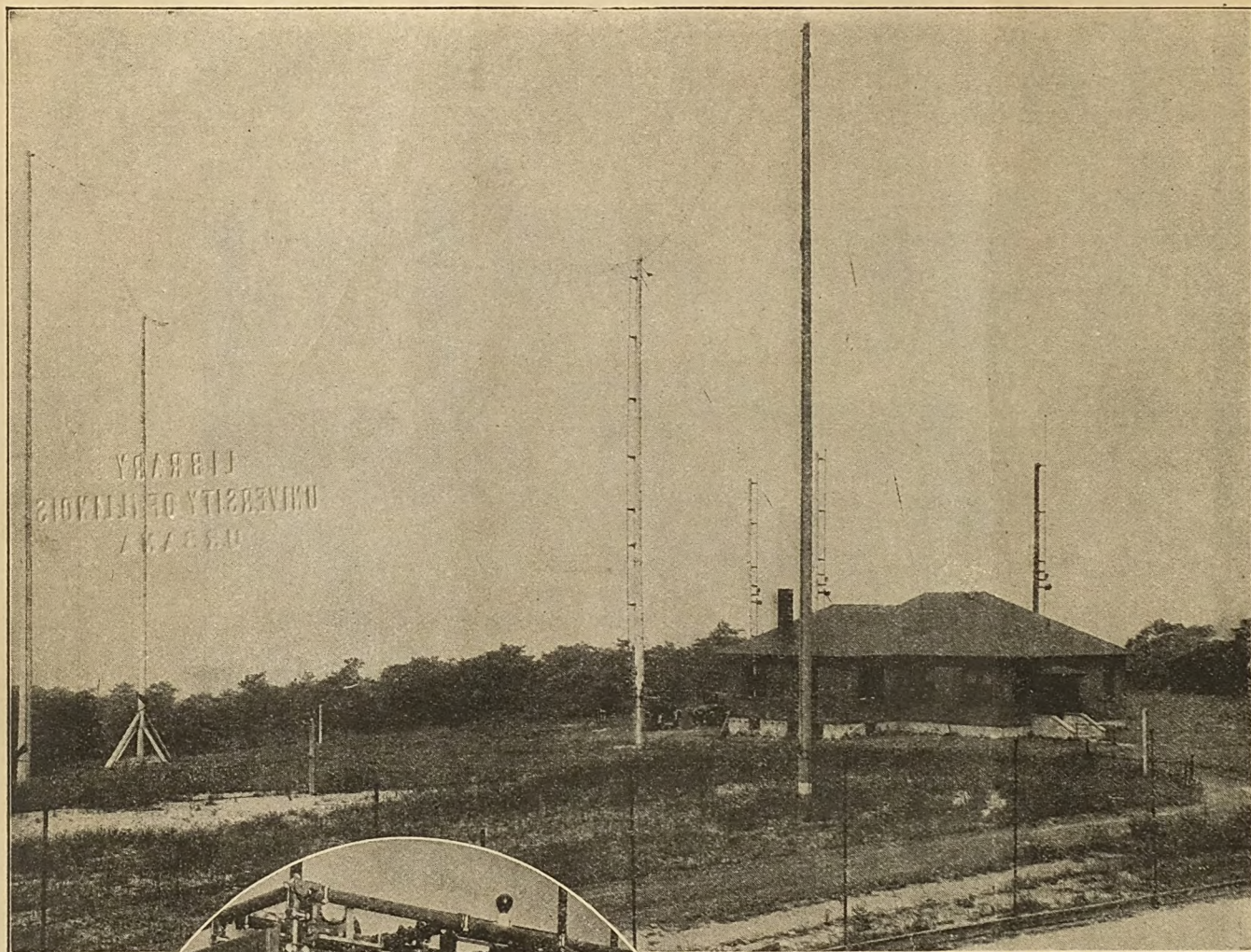
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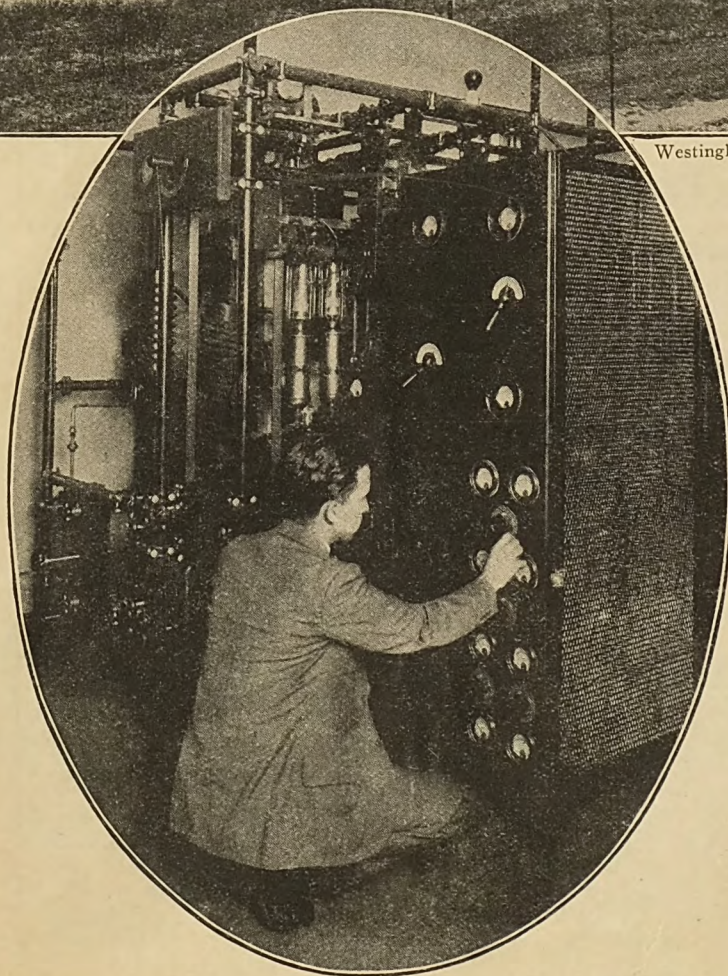
A Necessary Part of the Radio Industry

"In my estimation POPULAR RADIO is one of the most reliable and helpful magazines published in the interests of the radio novice, the amateur and the professional set builder. It is conservative without being stale, technical without being text-bookish. Any sane observer of radio conditions must regard POPULAR RADIO as a vital and necessary part of the radio industry."

Jack Hammarlund
SECRETARY
HAMMARLUND MFG. Co.



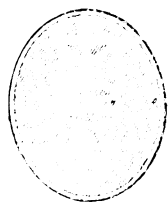
Westinghouse



Millions of Broadcast Listeners Have Never Heard This Powerful Station

Here is a broadcasting station whose programs are picked up daily in South America and other foreign countries, and yet few of our broadcast listeners have ever heard it. This is one of the short-wave stations owned and operated by the Westinghouse Electric Company of East Pittsburgh, Pa., and it is used to re-broadcast KDKA'S programs (8 to 10 P.M. nightly, except Sundays) on a special wavelength of 26 meters. Naturally, these programs are not available to the owners of standard broadcast receivers, since these receivers will not tune much below 200 meters. The picture above shows the special antenna system used in the experimental station, while the oval shows Mr. E. B. Langdon, manager of the station, adjusting the transmitter during recent attempts made to broadcast to Australia. This station has been in operation for several years, and yet many Americans do not know that it exists.

Popular Radio



VOLUME XIII

January, 1928

NUMBER I

GET READY TO LISTEN TO

36 Stations You Never Hear

*The new world of radio reception that is waiting
for every fan and broadcast listener*

HOW would you like to tune in tonight on a new Radio Utopia, where interference is non-existent, where static is at a minimum and programs are of the highest quality? How would you like to experience the new thrill of receiving over distances that you have heretofore thought impossible, but which now await only the idle twisting of a knob? Do you know that this fascinating radio world—this new crop of wavelengths—is immediately available to you, and that you can, by means of a very simple and inexpensive addition to your present receiver, bring to your fireside music of other lands?

At the present time there are in America no less than thirty-six broadcasters that you never hear—that are hopelessly beyond the wavelength range of your present receiver. The wavelengths employed by these strangers to your loudspeakers range from 26.3 to 109 meters, and the entertainment offered is every bit as good as that of the average broadcasters. As a matter of fact, WGY, WJZ and KDKA broadcast on short waves constantly, using their regular program features which are radiated simultaneously on their regular wavelength and the more or less private wavelengths of the several experimental short-wave transmitters.

Fishing for short waves is a fascinating

radio recreation full of new thrills and a new incentive for conquest. Inter-continental reception at last becomes a daily possibility with the far-flung waves of several continental stations easily within range of present-day receivers provided with the necessary auxiliary equipment. Not only this, but the chattering, active channels of the amateur telephone stations await the turn of your dials. Truly, this is a new wonderland of radio.

"What new equipment will I need?" you ask. Only a short-wave tuner with an oscillating detector so arranged that you simply plug it into the detector socket of your present receiver and, Presto! you have the key to another radio heaven, where you can escape the boredom and interference of conventional broadcasting.

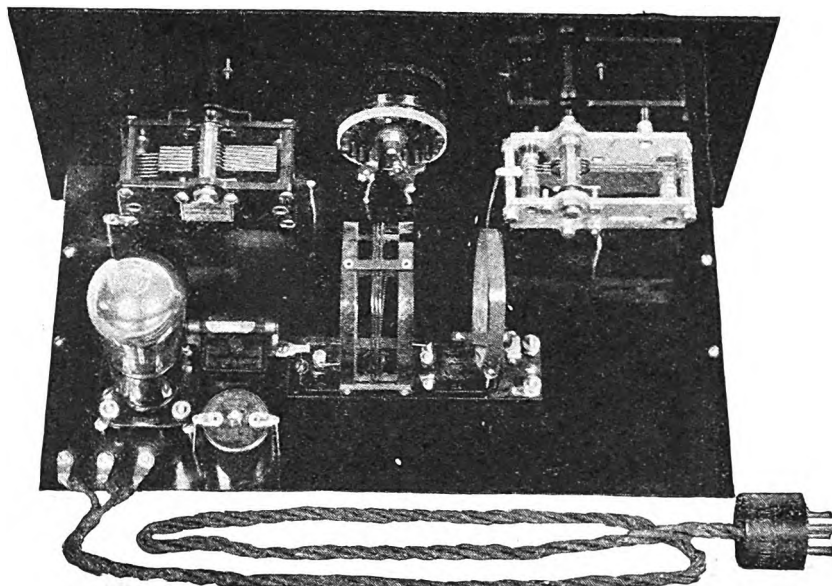
The next issue of POPULAR RADIO will begin a series of articles telling you how easily, how quickly and how cheaply you can equip yourself to enjoy the rich amusement offered by short-wave transmission. This instructive series will not only tell you how to assemble auxiliary equipment, but also how you may construct simple and inexpensive short-wave sets complete in themselves.

It is POPULAR RADIO'S belief that the development of the use of short waves will become of increasing importance and the final solution of the broadcasting problem lies in

more aggressive exploitation of wavelengths that are not now available to present broadcast receivers. This opinion is shared by many radio engineers, who see in the more or less futile efforts of the Federal Radio Commission the necessity for further research in the low-wave area of the radio spectrum. It has been definitely shown that static is less prevalent on the shorter waves and that

distance may be covered with little power.

Reception on these lower wavelengths opens up to the radio novice and experimenter a vast new area for exploitation and research. It is little wonder that radio fans are rapidly becoming enthusiastic listeners on the short wavelengths, and that there is a growing feeling in engineering circles that radio is on the eve of important changes.



AN INSTRUMENT FOR NEW RADIO DISCOVERIES

By plugging this simple unit into any standard broadcast receiver, the radio listener can bring into his receiving range all the absorbing radio traffic that goes on at the short wavelengths—amateur conversations, transatlantic calls and short-wave broadcasts.

36 Strangers to Your Dial

KDKA, 8 XK and 8 XP, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.

WGY (eight calls), 2 XAC, D, E, F, G, H, K and W, General Electric Company, Schenectady, N. Y.

WBZ, 1 XAE, Westinghouse Company, Springfield, Mass.

WHAM, 8 XAC, Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.

WABC, 2 XE, Atlantic Broadcasting Company, Richmond Hill, N. Y.

WEEL, 1 XAG and 1 XAF, Edison Electric Illuminating Company, Boston, Mass.

WJZ, Radio Corporation of America, Bound Brook, N. J.

WRAH, 1 XY, Booth Radio Laboratories, Tilton, N. H.

WRNY, 2 XAL, Experimenter Publishing Company, Coatesville, N. J.

WOR, 2 XAQ, Bamberger Company, Newark, N. J.

WRMU, 2 XAC, yacht Mu 1, Grebe Company, of New York.

WAAM, 2 XBA, WAAM, Inc., Newark, N. J.

KJBS, 6 XAR, J. Brunton & Sons Co., San Francisco, Cal.

KFWB, 6 XBR, Warner Brothers Studio, portable, Los Angeles, Cal.

KNX, 6 XA, *Los Angeles Express*, Los Angeles, Cal.

KFSG, 6 XBA, Air Fan Radio Corporation, Los Angeles, Cal.

KHJ, 6 XAU, *Times-Mirror* Company, Los Angeles, Cal.

KFWH, 6 XAK, F. W. Morse, Chico, Cal.

KFQZ, 6 XAL, L. E. Taft, Hollywood, Cal., portable.

KFVD, 6 XBX, McWhinnie Electric Company, Venice, Cal.

KNRC, 6 XAF, Clarence B. Junea, portable.

KGGM, 6 XAI, Los Angeles Radio Club, Los Angeles, Cal.

KFQV, 6 XBH, W. E. Riker, Holy City, Cal., portable.

WRAH, 1 XAA, Stanley N. Read, portable, Providence, R. I.

KFBC, 6 XBE, W. K. Azbill, San Diego, Cal.

KRLO, 6 XAN, Freeman Lan, Los Angeles, Cal.

KJR, 7 XC, 7 XO, Northwest Radio Service, Seattle, Wash., portable.

KWJJ, 7 XAO, Wilbur Jerman. Inc., Portland, Ore.

KFPY, 7 XAB, Symons Investment Company, Spokane, Wash., portable.

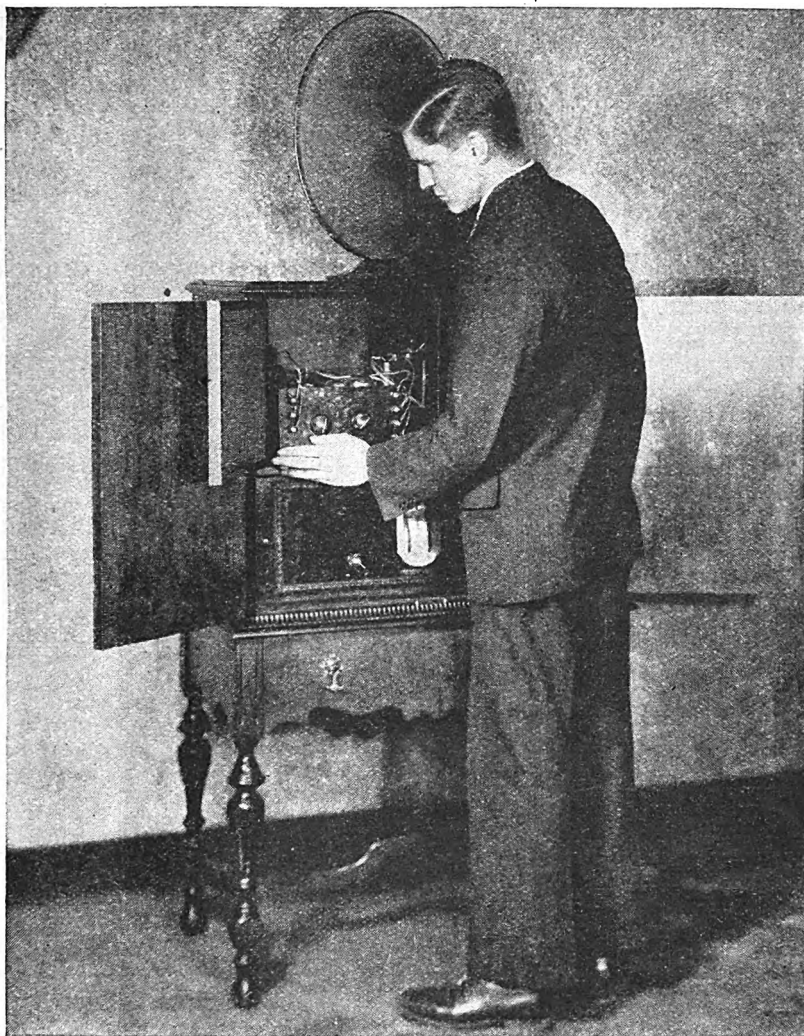
WEAO, 8 XJ, Ohio State University, Columbus, Ohio.

WLW, 8 XAL, Crosley Radio Corporation, Harrison, Ohio.

WHK, 8 XF, the Radio Air Service Corporation, Cleveland, Ohio, portable.

WNAL, 9 XAB, R. J. Boswell, Omaha, portable.

KOIL, 8 XU, Mona Motor Oil Company, Council Bluffs, Iowa.



The Hi-Q "B" power-pack fits easily in the Superior console cabinet for the Hi-Q receiver, shown at the left, and once installed it may be completely forgotten, as it requires absolutely no readjustment or upkeep.

Constructing and Operating the Hi-Q "Six" Power Supply

With "B" power from the lighting lines, the Hi-Q "Six" is a receiver that should satisfy the most critical fan. The unit described here is easy to construct, and is especially designed to supply silent "B" voltages to the Hi-Q receiver, as well as "A" and "C" voltages for the 171 power valve of the set.

By RAYMOND FRANCIS YATES

THE new Hi-Q power-pack has been designed to fulfill certain definite requirements in connection with the Hi-Q "Six" receiver, for the accomplishment of batteryless supply of "B" voltages.

It is a carefully engineered unit in which all the parts have been especially constructed in order to get the best operation possible. The unit will supply complete "B" voltages for the receiver, as well as "A" power and "C"

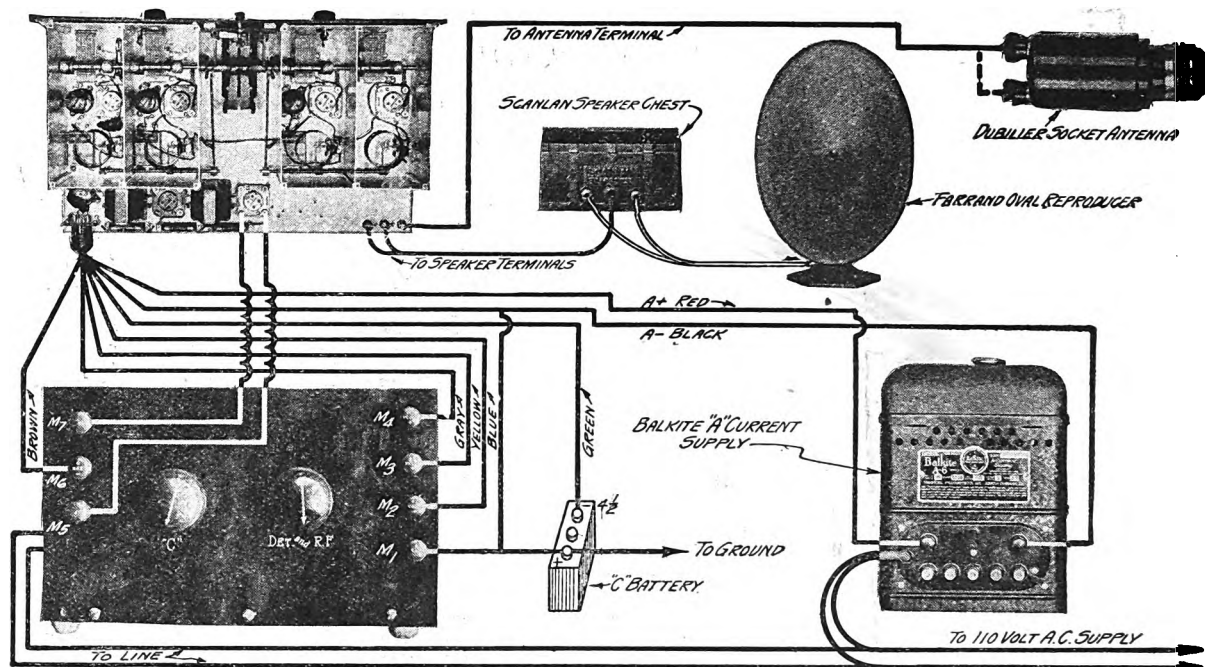
voltage for the last valve in the set, which is a 171 type.

For the purpose of obtaining stable and efficient operation, the unit is equipped with a variable control for the "C" voltage and a variable control for the "B" voltages of the high-frequency valves.

A regulator valve is also employed for maintaining exact potentials for all the other parts of the circuit.

The power block is attached to the

house-lighting lines, with a plug for adjusting the entire AC power for line voltages from 105 to 120 volts, thus further insuring correct operation. The complete power-pack may be assembled and placed in operation, once the parts and accessories have been obtained, with less than an hour's work. The wiring is easily done by even the most inexperienced set builder by following the instructions on the work sheet and diagram accompanying this article.



AN EXCELLENT POWER HOOK-UP FOR THE HI-Q

FIGURE 1: In the hook-up shown here the Hi-Q receiver is operated entirely from the AC lighting lines, with the exception of the small, semi-permanent "C" battery. The units shown here were found by tests to give excellent results when hooked up as indicated by the heavy black lines.

How to Assemble the Hi-Q Power-Pack

After all the instruments and materials have been procured, the parts should be mounted on the baseboard, L. In Figures 3 and 4 the arrangement of these parts is shown.

The power block, A, and the condenser block, B, should be mounted side by side in the positions indicated in these figures. Then the two sockets, C and D, should be mounted in position by means of two wood screws each.

Next the resistance and mounting, E, and the fixed condenser, F, should be placed in the correct position and screwed down to the baseboard with two wood screws to each instrument. These positions are also indicated in Figures 3 and 4.

The next job will be to mount the resistor units, H and I, on the right

side of the front panel, K, in the holes already drilled for them. These two units are fastened together by the manufacturer and are mounted with a single hole mounting. Then the variable resistor, J, should be mounted in the hole at the left of the front panel, K. Then the seven binding posts, M1, M2, M3, M4, M5, M6 and M7, should be mounted in their respective positions on the front panel, K, as shown in Figures 3 and 4. This makes the assembly work complete, except for the mounting of the tapped resistor, G. This is fastened to the top binding post, M4, by the extension lug, and screwed tight with two nuts on the back of the binding post. The other end of this resistor is held by the wiring when that is being done. The front panel itself may then be fastened by

three wood screws screwed through the three holes and into the edge of the wooden baseboard, L.

This done, four rubber feet may be attached to the four corners of the baseboard on the bottom side.

How to Wire the Unit

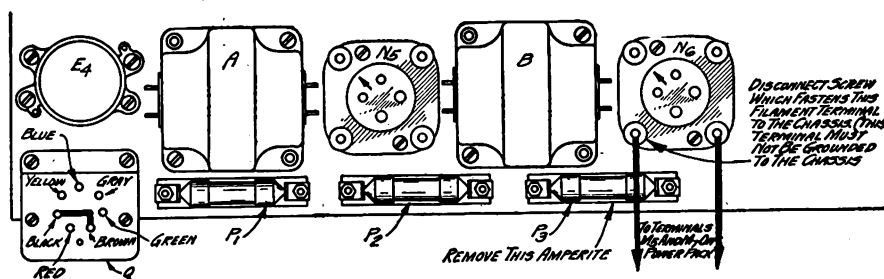
It is recommended that all wiring of this unit be done with a stranded insulated wire, such as celatsite.

In wiring up, refer constantly to the picture wiring diagram in Figure 4.

In this diagram all of the instruments and parts are outlined in black lines, while the wiring itself is shown in heavy blue lines. Start by tracing a single lead from its start to its finish, on the diagram, continuing through until every connection has been made. The dotted blue lines in the diagram indicate where the wiring is run underneath the wooden baseboard, L. When the wiring runs from the top of the baseboard to the bottom of the baseboard holes are to be drilled, and the positions are also indicated in Figure 4. When the wiring has been completed, carefully check over every wire and see that no single item has been missed and that no other mistakes have been made.

There are also a few slight changes necessary in the wiring of the Hi-Q receiver in order to install the power pack. These changes are shown clearly in Figure 2. A wire should be run b

(Continued on page 61)

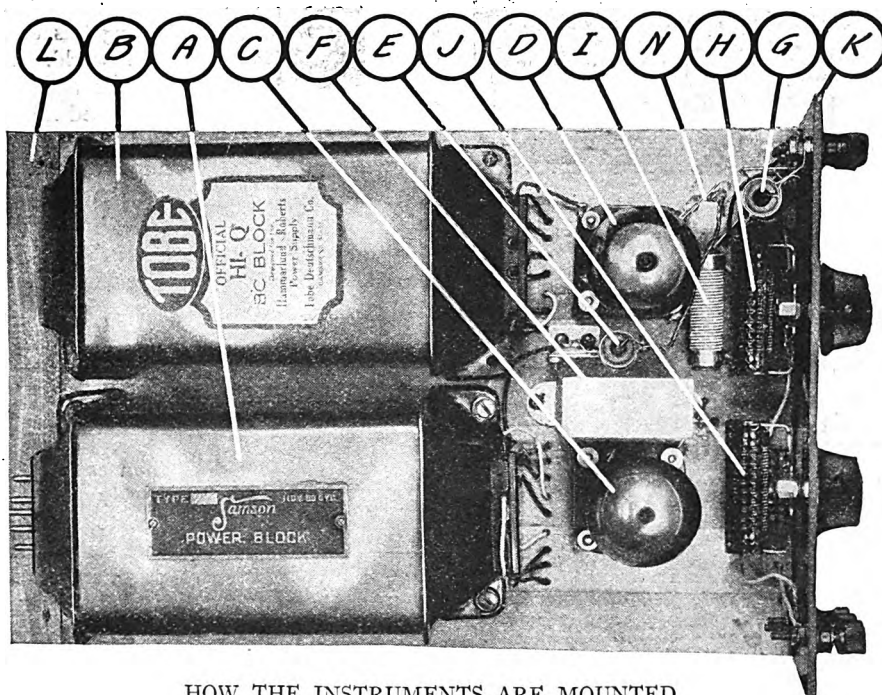


THE CHANGES NECESSARY IN THE RECEIVER

FIGURE 2: This diagram gives the few additions to the wiring of the receiver necessary in installing the power unit. A short wire is attached between the black and brown terminals of the Yaxley plug. One amperite is removed, and two separate wires are brought out for the filament supply to the last valve.

POPULAR RADIO WORK SHEET

THE HI-Q POWER-PACK



HOW THE INSTRUMENTS ARE MOUNTED

FIGURE 3: The spacing of the instruments on the baseboard should conform exactly to the layout shown above.

LIST OF PARTS FOR BUILDING THIS UNIT

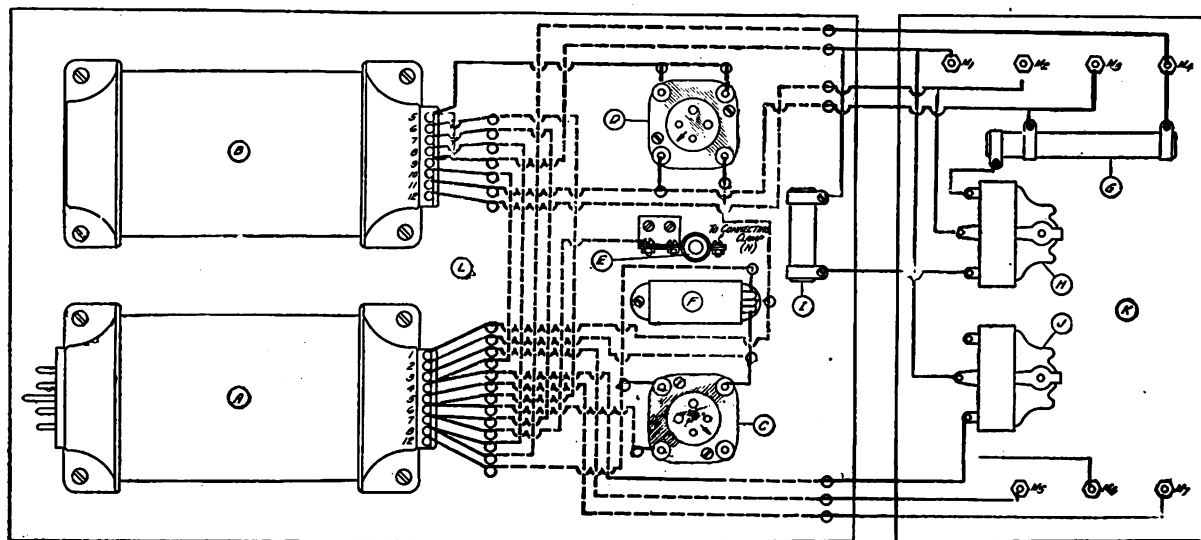
COST OF PARTS—Not over \$59.00

A—Samson power block, type 713;
 B—Tobe Hi-Q "BC" condenser block;
 C and D—Benjamin Cle-ra-tone sockets;
 E—Electrad Truvolt resistor, No. 3;*
 F—Tobe precision buffer condenser, .1 and .1 mfd., No. 411;
 G—Electrad Truvolt No. 1 tapped resistor;*

H and I—Electrad Truvolt No. 2 combination resistor, H referring to the variable resistor element and I referring to the fixed resistor element of this unit;*
 J—Electrad Truvolt No. 4 variable resistor;*
 K—Micarta drilled and engraved front panel, 9 by 5½ inches;

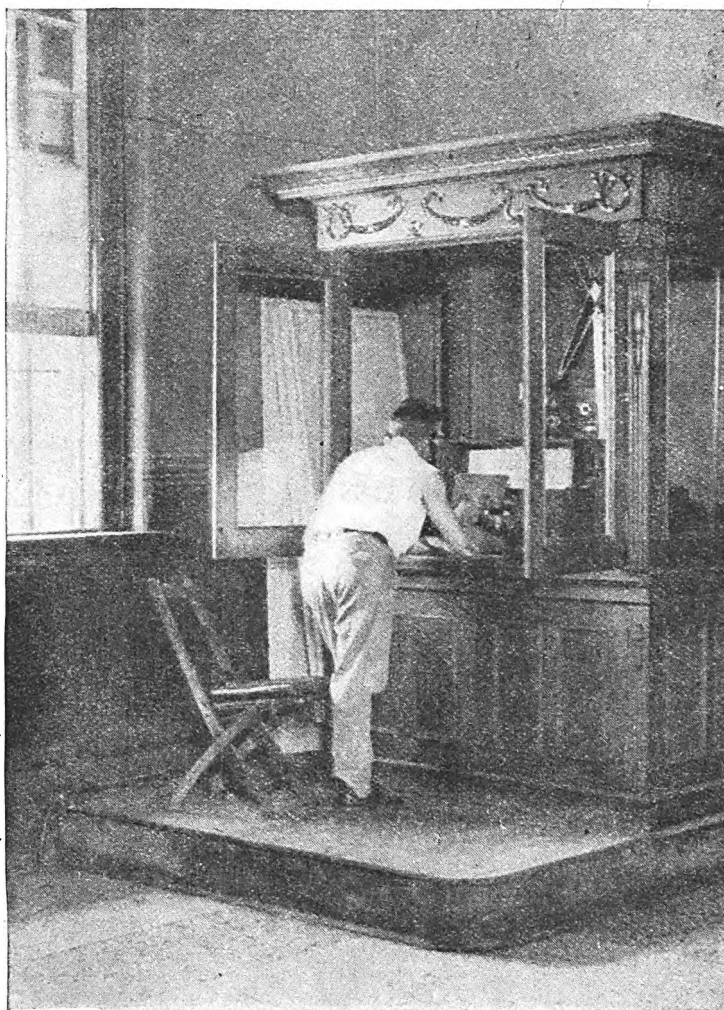
L—Wooden baseboard, 13½ by 9 by ½ inch;
 M1, M2, M3, M4, M5, M6 and M7—Eby binding posts;
 N—Special Fahnestock valve connector for Raytheon voltage regulator valve, type 7.

* These four units are packed as the Electrad Hi-Q Truvolt resistance kit.



HOW TO WIRE THE UNIT

FIGURE 4: The instruments are outlined in black; the wiring above the baseboard is shown in solid blue, and that below the baseboard in dotted blue.



Kadel & Herbert

BRINGING THE OUTSIDE WORLD TO SING SING

It is probable that there are few more popular spots in Sing Sing Prison than the radio receiver control booth, shown above, where the broadcast voices from the outside world are brought into the dreariness of prison routine. It is operated by the prisoners themselves during the early evening hours.

WARDEN LAWES TELLS ABOUT RADIO AT SING SING

FROM AN INTERVIEW WITH
LEWIS E. LAWES, *Warden of Sing Sing Prison*

RADIO has had a soothing and beneficial effect upon human life in many of its vicissitudes. In the hospitals it has a distinct therapeutic value, bringing cheer and encouragement to those who are temporarily or permanently incapacitated. Its influence on home life is immeasurable, and no one will know the good it has accomplished until some super-sociologist discovers a way of calculating its effect.

But what about radio in the prisons? Surely there must be some opportunity for it to work its miracles in our penal institutions, where life is, of necessity, reduced to a state of deadening mo-

notony and restricted activity. If radio sounds good to the ears of a free man, it must sound good to the man behind the walls and bars.

Moreover, it is bound to affect a man spiritually and emotionally who is considered an enemy of society, and whose hopes and ambitions must be at low ebb. In my experience at Sing Sing, I find that radio is beneficial in more ways than one. It has a constructive effect upon the prisoners, many of whom will eventually return to society. It broadens their minds and keeps their thoughts in clean and constructive channels, which is infinitely better than

allowing them to stagnate in that ominous depression that prevails in the cell. Those prisoners who are returned to society will, I am sure, be better men for having had the opportunity of experiencing this daily contact with the outside world. After all, nothing is a greater anodyne to a tired soul or a depressed mind than music. And radio is able to supply that, along with its inspiring messages from men of success and affairs.

I find, also, that radio is one of the most effective means of promoting good discipline among the prisoners at Sing Sing. While radio entertainment is not a special privilege, it is denied to those who are under discipline for some infraction of the rules of the institution. Broadly speaking, I would say that from our point of view, when radio entertainment is denied a man, it is not done simply to deprive him of enjoyment, but to help promote the discipline of the place. It is something that the prisoners like and something that can be denied them unless they are in good behavior. I say this without for one moment losing view of the fact that it has a sociological value of great importance.

The radio receiver at Sing Sing was installed by the prisoners themselves and is maintained through the permission of the prison authorities. The program material allowed to reach the prisoners is carefully supervised so as to exclude anything that might have a detrimental or unfavorable appeal. An attempt is made to keep the material received inspiring and of a high cultural value. The receiver itself is usually manipulated by an old and tried "trustee."

It is interesting to note an excerpt from a letter received by a radio station from an inmate of another prison. It shows how keenly these men criticize the things that they hear, and how alert they are to discover character and personality as it is revealed by the voices of the men who manage the "Mikes" at our broadcasting stations:

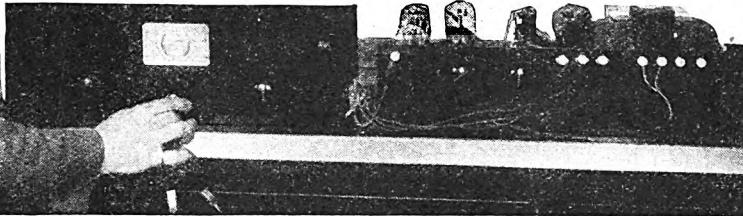
"From the voices of certain ones seems to emanate a cold, cultured smirk; others give the impression of a slap on the back and an ether-disturbing har! har! We know some stations that always seem to hand us a neighborly grin; from one place a certain chuckle is as sure a guide as the station's letters. But once in a while we hear a voice so kindly, so understanding, so tolerant that it brings with it the Friendly Smile. A few that come to my mind: Major Bowes and Roxy from New York; B. J. Fahner and Pete McArthur from WOC."

Here's the 1928 Browning-Drake!



In the new Browning-Drake tuner for 1928, you get all the advantages of the old models, *plus* larger and more powerful valves, complete AC or DC operation, drum dial tuning and many other refinements in design and operation—and, as the details below show, it is undoubtedly the easiest of all Browning-Drakes to assemble and operate.

By GLENN BROWNING



At the left the Browning-Drake tuner is shown with the AmerTran push-pull amplifier in a power hook-up of splendid quality. The details of this hook-up are described on page 77 of this issue of POPULAR RADIO.

FUNDAMENTALS in radio design have not changed much in the past few years, contrary to the belief of the general public, and receivers which were originally based upon sound electrical principles have remained practically unchanged. The original Browning-Drake circuit of 1924 has had very few changes made in its essential principles. However, it has been found advisable, from time to time, to change the mechanical design so that the receiver might be brought up to date in appearance and also to incorporate electrical improvements which have developed in the last few years.

Due to the fact that many fans are desirous of using power amplifiers which incorporate either 171 type valves in push-pull arrangement or 210 type valves, in order to get a large amount of undistorted energy delivered to the reproducer, it is thought advisable to describe in this article a two-valve Browning-Drake tuner combined with the new AmerTran power-pack amplifier. This makes a fine combination, inasmuch as a tremendous undistorted volume may be delivered to the reproducer.

The Browning-Drake circuit consists essentially of one stage of tuned-high-frequency amplification, with a specially built slot-wound high-frequency transformer which was developed by the writer and Dr. F. H. Drake. This is combined with a regenerative detector, the stage of high-frequency amplification being neutralized. The resulting combination makes a tuner which is both easy to build and sufficiently sensitive to enable the operator to receive almost all signals which are above the noise level.

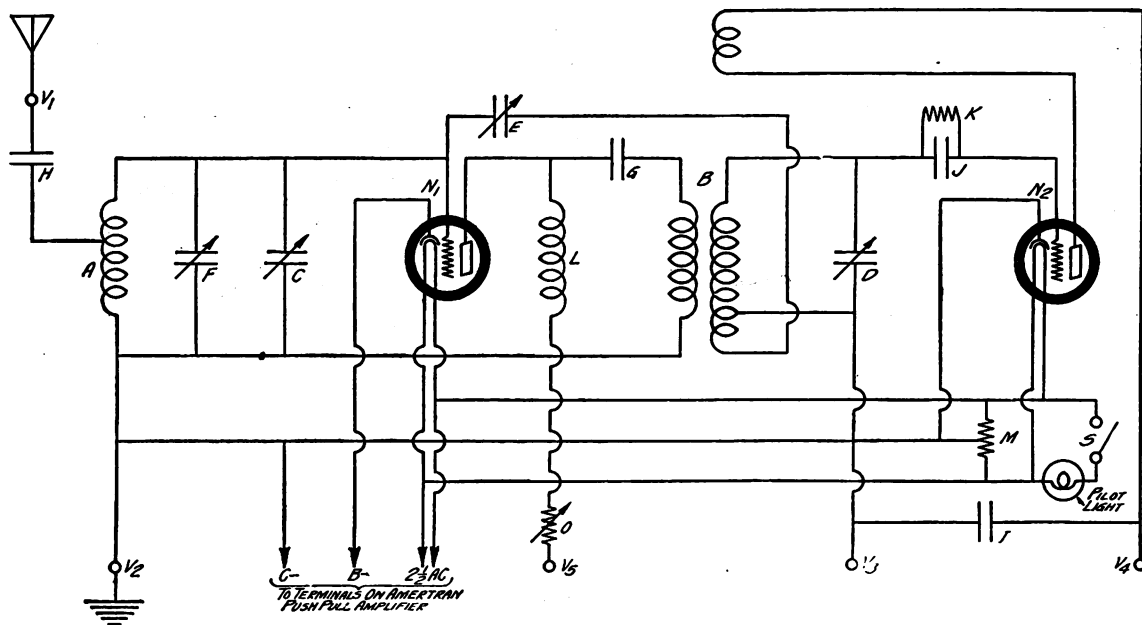
The antenna circuit incorporated in the Browning-Drake receiver is a con-

ductively coupled one; that is, the antenna lead connects directly to a tap on the antenna coil through a .0001 mfd. condenser. This system has proven extremely efficient, inasmuch as it has a much more even response over the entire broadcast band of frequencies than any other simple circuit tested by the author. Another advantage is that good signal strength may be secured when using even an extremely short antenna. One disadvantage, however, is that it is extremely difficult to make the two condensers on the receiver run together when both long and short antennas are being used alternately. Dr. Drake and the writer have, for the past season, been working on what might be termed a "single control" for this circuit and have so designed the receiver that the tuning condensers employed may be attached to one shaft and controlled with a drum-type illuminated dial without making any other adjustments for certain types of antennas. The receiver described, however, employs what is termed a "trimmer condenser" in parallel with the first tuning condenser. The operator will find that, in most cases, it will be necessary to make slight adjustments on this for different stations.

Another change which has been made is that a neutralization system has been developed in order that a large valve may be used as the high-frequency amplifier. The neutralization system, as will be noted from the schematic wiring diagram in Figure 1, consists of a number of extra turns added on the secondary of the high-frequency transformer, with the end connected to the rotor plates of the neutralizing condenser, the stator plates then being connected to the grid of the first vacuum valve. It has also been found advisable, even with this system of neutrali-

zation, to keep all high-frequency currents out of the "B" supply. Consequently a condenser of .5 mfd. capacity is placed in the line which runs to the primary of the high-frequency transformer, and a parallel feed is employed which incorporates a high-frequency choke connected directly to the plate circuit of the vacuum valve, the other end going to a variable resistance and then to the "B" supply. Perhaps some of the readers may wonder why a .5 mfd. condenser was used in this parallel feed system, inasmuch as it would seem that high-frequency currents could readily pass through as small a condenser as a .006 mfd. It is true that the high-frequency currents can pass through a .006 condenser, but the .006 has a large impedance to all low-frequency currents, and it is known that if a plate impedance is added in a high-frequency amplifier valve detection of signals occurs in this valve and it does not act solely as a high-frequency amplifier. Therefore, keeping this in mind, various sizes of condensers were experimented with, and it was found that a .5 mfd. condenser was about as small as could be used in the place indicated above without seriously impairing the operation of the first vacuum valve.

Shielding is, for the first time, being recommended for the kit set circuit. The previous official kit set was made as sharp as possible, but when located within a radius of a few miles from broadcasting stations it was found that such a large amount of signal was picked up on the coils and the wiring of the set that it was extremely difficult to receive distance while the locals were on. When located as much as four or five miles from broadcasting stations, the receiver operated very satisfacto-



THE HIGH-FREQUENCY CIRCUITS OF THE RECEIVER

FIGURE 1: In this schematic diagram of the Browning-Drake circuit the high-frequency amplifier and detector valves are shown wired for AC operation, in conjunction with the new AmerTran push-pull amplifier and power-pack described on pages 20-22 of this issue.

rily, however. The set builder may now choose whether to shield the receiver completely or not, and he should govern his choice by his local receiving conditions. If he is located in an extremely congested section, he should, by all means, completely shield the two-valve tuner; on the other hand, if he is located in the country, this would be an added expense and is unnecessary. In order to facilitate the use of shields and not make the tuner too cumbersome, it was found necessary to cut the tuning coils down from the 3-inch form to a 2-inch form. The shielding, in all cases, must be kept a distance of 1 inch away from the low potential end and a distance $1\frac{1}{2}$ inches away from the high potential end of the coils, in order that their efficiency be not reduced.

The kit for the new Browning-Drake might be termed a "single-mount unit," as the instruments it employs—two Browning-Drake condensers, driven by the single illuminated drum dial, together with the two coils necessary for the circuit—are all mounted to make a single unit. In fact, it is only necessary to secure the foundation unit, which consists of front and base panel and mounting hardware, to make a tuner which may be used with any type of low-frequency amplifier. Furthermore, it may be constructed for operation with either AC or DC vacuum valves.

How to Assemble the Receiver

Although the two-valve tuner is quite easy to assemble, with the aid of the

accompanying work sheet and diagrams, a few constructional tips might be given to advantage. There are two long leads in the set which carry high-frequency currents; one runs from the .5 mfd. condenser in the plate circuit of the high-frequency valve to the primary of the high-frequency transformer, and the other runs from the end of the high-frequency transformer to the rotor plates of the neutralizing condenser.

These two connections should be kept away from all other leads. Other high-frequency connections, such as that from the stator plates of the condenser to the grid of the vacuum valve, should be run as directly as possible.

In order that the set builder may use shielding if his location is such as to demand it, a metal sub-panel is employed.

The grid-leak on the detector valve is suspended by a stiff wire from the stator plates of the second tuning condenser directly to the grid connection on the valve.

Using AC Valves in the Set

If the set builder desires to use the new type AC valves, he should provide himself with two five-prong sockets, as well as one center-tapped resistor of about 50 to 100 ohms. He should also secure two 227 type AC valves. These are heater type valves and require a step-down transformer which supplies $2\frac{1}{2}$ volts to heat their filaments. The filament connections should be made by means of two wires twisted together. This is extremely necessary if there is to be no AC hum

in the completed receiver. All the twisted pairs also should be run underneath the sub-panel. The high-frequency valve should have from 3 to $4\frac{1}{2}$ volts of negative "C" battery bias. No binding posts are put on the sub-panel for this connection, as it is best to run them out in a cable, preferably using two different colored wires twisted together.

The set builder will find that if he is extremely careful in constructing the receiver for use with these valves he will get no hum whatsoever. It is sometimes necessary, instead of connecting the cathode directly to the center point of the filament circuit, to put in a 22 or 45-volt bias, as recommended in the instructions which accompany the valves. The writer, however, found that in the majority of cases this was not necessary and that the cathode can be connected directly to the center tap of the resistor which is connected across the filaments. A little experimenting on this point is well worth while.

Balancing the Set With AC Valves

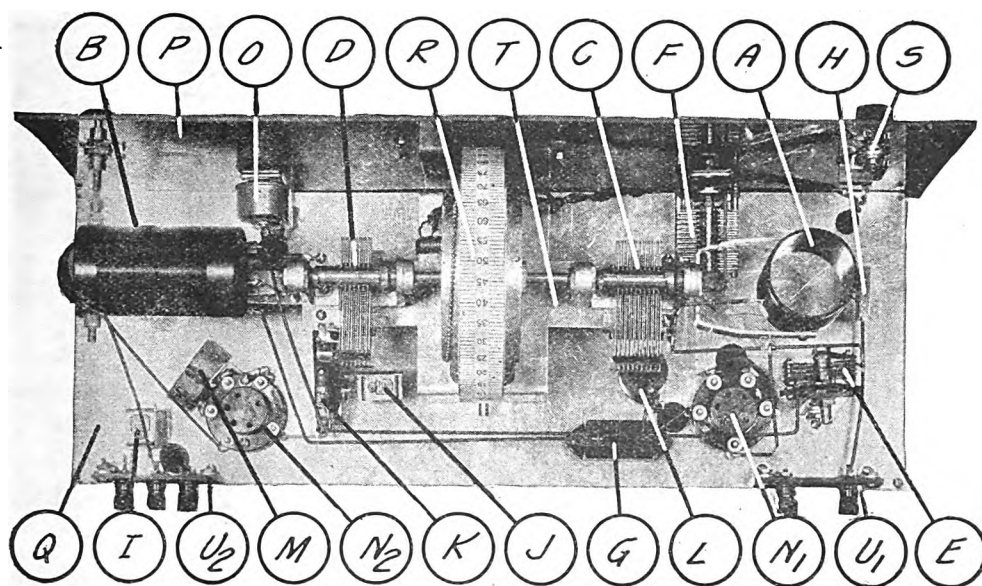
In case the set builder chooses to use AC valves with the two-valve Browning-Drake kit set, the balancing or neutralizing of the set should be done as follows:

The Clarostat, which is used as a volume control, should be turned clockwise as far as it will easily go. Set the condensers at a low value, say 20 on the scale. Turn the tickler coil down until the second circuit is oscillating. This may be determined by

(Continued on page 75)

POPULAR RADIO WORK SHEET

THE 1928 BROWNING-DRAKE



HOW THE INSTRUMENTS ARE MOUNTED

FIGURE 2: The mounting of the instruments is much simplified by the fact that the sub-panel comes ready drilled with mounting hardware.

LIST OF PARTS FOR BUILDING THIS RECEIVER

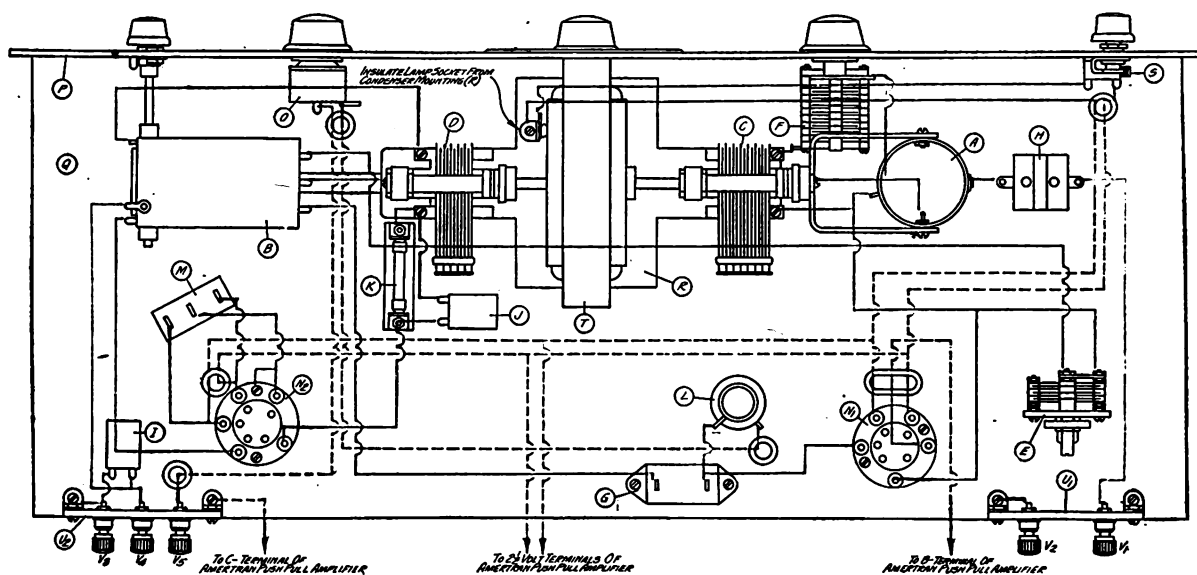
COST OF PARTS—Not over \$55.00

Browning-Drake single-mount kit, containing:

- A—Browning-Drake antenna coil;
- B—Browning-Drake high-frequency transformer;
- C—Hammarlund midline variable condenser, .00045 mfd.;
- D—Hammarlund midline variable condenser, .0003 mfd.;
- R—Browning-Drake illuminated drum dial;
- T—Aluminum bracket, mounting brackets and hardware;
- E—Browning-Drake special neutralizing condenser;

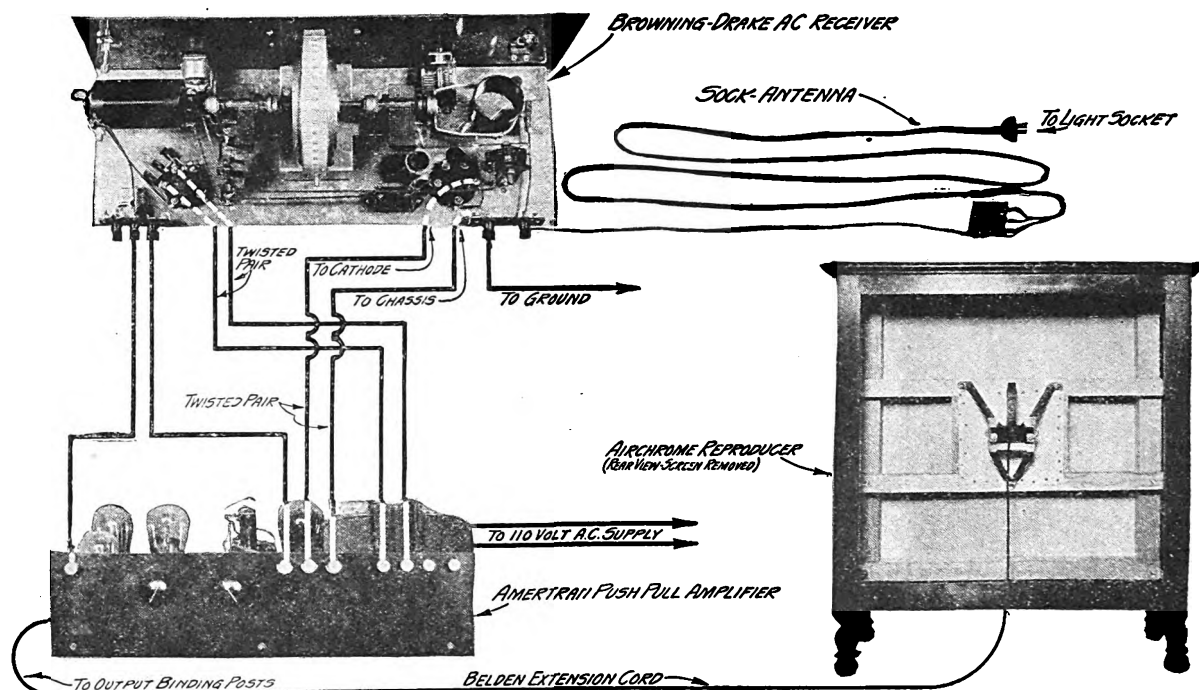
- F—Browning-Drake variable midget condenser, .000135 mfd.;
- G—Aerovox or Tobe .5 mfd. special blocking condenser;
- H—Aerovox fixed condenser, .0001 mfd.;
- I—Tinytobe fixed condenser, .001 mfd.;
- J—Tinytobe fixed condenser, .00007 mfd.;
- K—Tobe Veritas grid-leak, 6 megohms, equipped with a standard Lynch mounting;
- L—Browning-Drake high-frequency choke coil;
- M—General Radio center-tapped resistor, 100 ohms;

- N1 and N2—Benjamin Cle-ra-tone 5-prong sockets;
- O—Clarostat variable resistor;
- Browning-Drake foundation unit, consisting of:
- P—Built and engraved front panel;
- Q—Drilled aluminum sub-panel complete with mounting hardware;
- S—Yaxley offset filament switch;
- U1 and U2—Micarta binding-post strips;
- V1, V2, V3, V4 and V5—Eby binding posts;
- Wire, solder, etc.



THE WIRING OF THE RECEIVER

FIGURE 3: The instruments are in black. The wiring above the sub-panel is indicated in solid red lines, and that below the sub-panel in dotted red lines.



A COMPLETE SET-UP FOR THE AMPLIFIER

FIGURE 1: In this combination hook-up the new power-pack amplifier is shown connected to the 1928 AC Browning-Drake. All of the connections are shown in BLACK lines, including the connection to the Tidmarsh light-socket antenna, the AC lighting lines and the new balanced-tension reproducer.

Push-Pull Amplification! "ABC" Power! The AmerTran Amplifier

The remarkable unit described in this article not only furnishes an ideal form of distortionless low-frequency amplification for any high-frequency pack, but supplies ALL the operating voltages for any set that employs AC valves

By LAURENCE M. COCKADAY

IT is agreed by radio engineers and experts that the push-pull method of low-frequency amplification gives the best results for a power stage to work directly into a reproducer. For this reason radio fans and set builders who are trying to keep up to the minute with their radio receiving apparatus should be interested in the latest and most powerful amplifier of this type.

The complete amplifier that is described in this article consists of one stage of low-frequency amplification using a high-quality transformer with an AC valve, followed by a second stage embodying the latest improvements in push-pull amplification, with two 210-type power valves and a very efficient output transformer, operated entirely from the 110-volt, 60-cycle lighting lines, without the use of batteries.

The unit also supplies AC filament current for five 226-type AC valves and three 227-type AC valves for operating almost any type of receiver, such as the new Browning-Drake high-frequency pack or the LC-28 high-frequency pack, with which the amplifier is desired to be used. The unit supplies, as well, the "B" and "C" voltages for the complete high-frequency pack and for the first and second low-frequency amplifier stages. In other words, the new unit is a complete "ABC" power-pack and low-frequency power amplifier for any receiver that can be equipped with AC valves.

Special consideration has been given to the frequency range of the new amplifier so that it will reproduce with the greatest possible accuracy all frequencies in the range of audibility.

How to Assemble the Push-Pull Power-Pack Amplifier

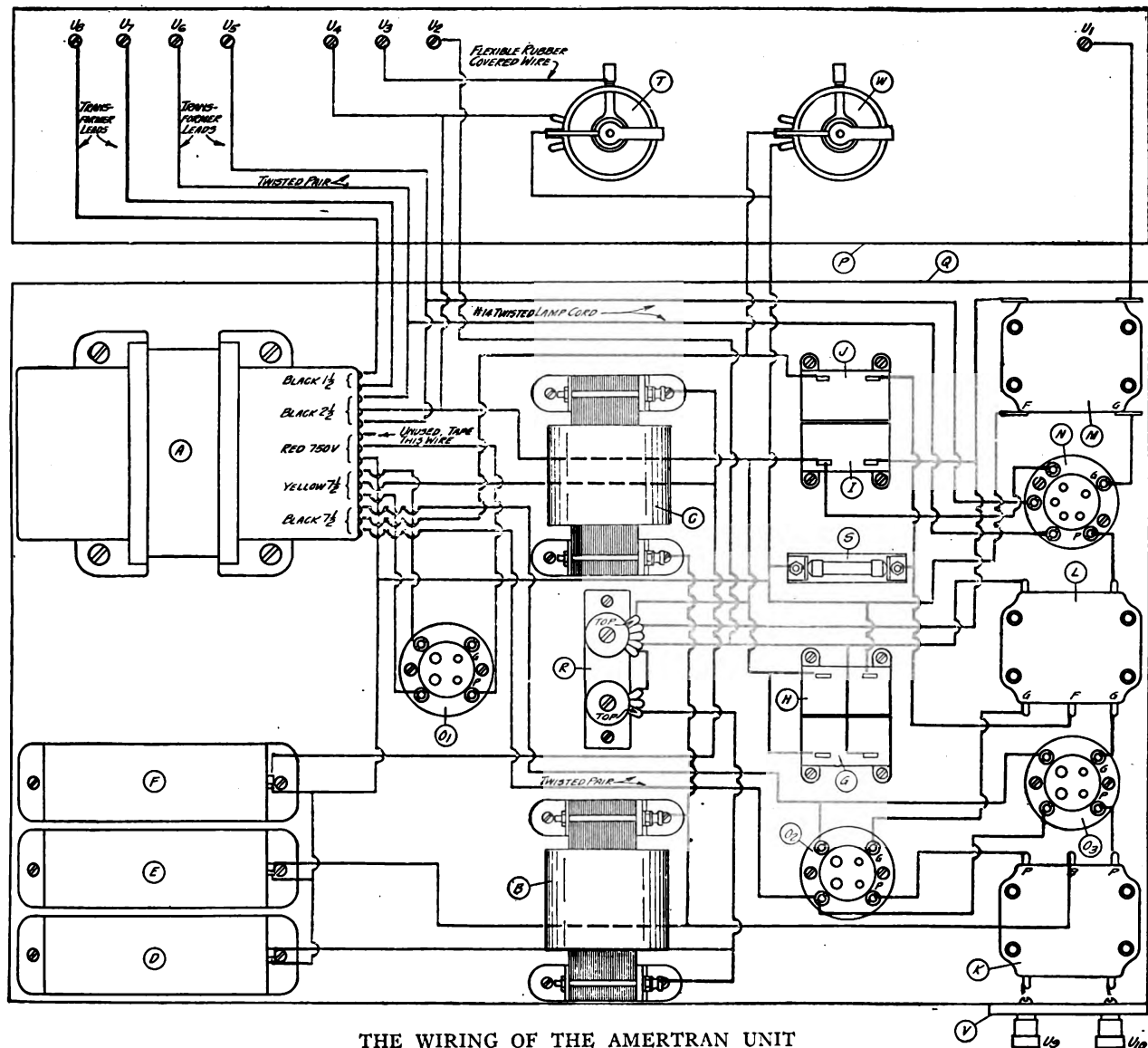
The first job is to prepare the wooden baseboard, Q. This should be cut to the size of 12 by 18 by $\frac{3}{4}$ inch thick, out of hardwood stock, preferably oak. It may be finished with a dull stain and allowed to dry.

Next the power transformer should be mounted in approximately the position shown in Figure 3, with the secondary side turned in the position as shown. Four large round-head iron screws are used in mounting it, with suitable washers placed between the screw heads and the frame.

Then mount the two filter chokes, B and C, and the AmerTran resistor, R, as shown in the same diagram. Notice that there are two sizes of filter chokes and that they must be used in

POPULAR RADIO WORK SHEET

THE AMERTRAN AMPLIFIER AND POWER-PACK



THE WIRING OF THE AMERTRAN UNIT

FIGURE 2: All the wiring in the AmerTran unit is done above the baseboard, and is indicated in this diagram by solid red lines. The instruments are outlined in black. The spacing of the instruments should follow that shown in Figure 3, as the spacing shown above has been changed slightly to make the wiring clearer. The spacing of instruments is important in this unit, since the magnetic fields of the various chokes and transformers might interact and cause an AC hum if the units are not correctly spaced.

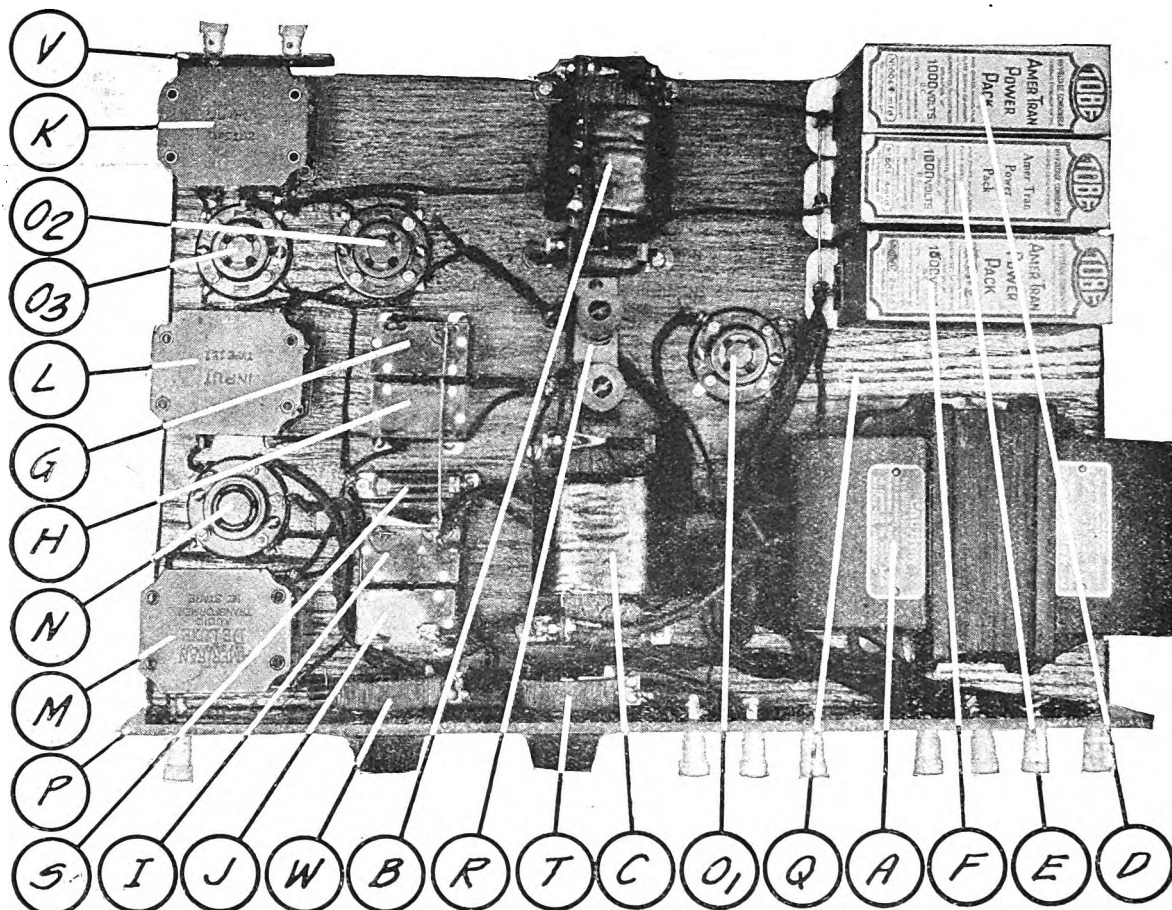
LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$125.00

A—AmerTran power transformer, type PF-281;
 B—Amerchoke, No. 854;
 C—Amerchoke, No. 709;
 D and E—Tobe filter condenser for AmerTran power-pack, No. 604, 4 mfd., 1,000 volts DC;
 F—Tobe filter condenser for AmerTran power-pack, No. 1102, 2 mfd., 1,500 volts DC;
 G, H, I and J—Tobe by-pass condenser, 1 mfd., 300 volts DC;

K—AmerTran output transformer, type 152;
 L—AmerTran input transformer, type 151;
 M—AmerTran Deluxe transformer for first stage;
 N—Na-ald 5-prong vacuum valve socket, No. 427;
 O1, O2 and O3—Na-ald 4-prong vacuum valve sockets, No. 426;
 P—Formica connection panel, 18 by 4½ by 3/16 inch;

Q—Hardwood baseboard, 18 by 12 by ¾ inch;
 R—AmerTran resistor, type R-400 (new style);
 S—Aerovox Metalohm, 50,000 ohms, equipped with mounting;
 T and W—Centralab fourth terminal potentiometers, 2,000 ohms;
 U1 to U10—XL binding posts;
 V—Formica binding-post strip, 3 by 2 by 3/16 inch;
 Wire, screws, etc.



THE EXACT LAYOUT OF THE AMERTRAN UNIT

FIGURE 3: For best results, the instruments and parts should be mounted exactly as they are in the view above, to reduce the interaction of the magnetic fields to a minimum.

the proper places; the large one, No. 709, is lettered C. Next mount the three filter condensers, D, E and F, by means of two screws to each instrument, as shown in Figures 2 and 3. The next job is to mount, on the baseboard, Q, the transformer, M, the input transformer, L, and the output transformer, K. These should first be placed in position and the three sockets, N, O2 and O3, should be spaced with enough room for the connections and then all six instruments should be fastened down. Next mount the remaining socket, O1, with its terminals turned in the position shown, and mount the by-pass condensers, G, H, I and J. These are fastened back to back and screwed to the baseboard with two screws through each instrument. Then fasten down the resistor, S, as indicated. This completes the construction work on the baseboard, Q.

The next job is to cut the Formica binding-post strip, V, to a size of 2 by 3 by 3/16 inch thick, out of 1/4-inch stock. The two XL binding posts, U9 and U10, should be attached, as shown, and the binding-post strip may then be fastened into the edge of the baseboard,

Q, by means of two screws passing through it and into the edge of the wood.

Now the large connection panel, P, should be cut out of 1/4-inch Formica to the size of 4 1/2 by 18 by 3/16 inch. Holes for eight binding posts should be drilled in it, approximately as shown in Figure 3, and two holes should be drilled for the potentiometers, T and W. These two latter holes should be first marked in so that the two potentiometers will not interfere with any of the other instruments mounted on the baseboard. The top view in Figure 3 shows the exact positions that are to be carefully carried out in mounting all of the instruments. The layout shown in this picture must be followed as closely as possible if the unit is to operate successfully without hum. The picture wiring diagram in Figure 2 does not give the correct spacing of parts.

When the panel, P, has been prepared and the eight binding posts, U1, U2, U3, U4, U5, U6, U7 and U8, and the two potentiometers, T and W, have been mounted in the positions shown in Figure 3, the panel itself may be attached

to the edge of the baseboard, Q, by means of three strong wood screws, placed through holes in the panel, P, and screwed into the edge of the baseboard, Q.

This completes the construction and assembly of the unit and it is now ready to be wired.

How to Wire the Amplifier

All of the connections for this new unit, except the AC filament leads, are to be made with Corwico Braidite, which is a braided insulation wire heavily waxed. This wire gives ample insulation and at the same time is easy to work with because of the fact that it may be cut into the correct lengths and then the insulation is easily pushed back before soldering it in place. The wire needs no scraping or cleaning.

First of all connect up the filament leads to the binding posts, U5, U6, U7 and U8. These are the AC filament leads and should be made with the lengths of wire with which the transformer is equipped. They should be bent around in a neat position and attached directly to these four binding

(Continued on page 77)

TUNE IN ON BETTER RESULTS WITH THE HARKNESS COUNTERFONIC SIX

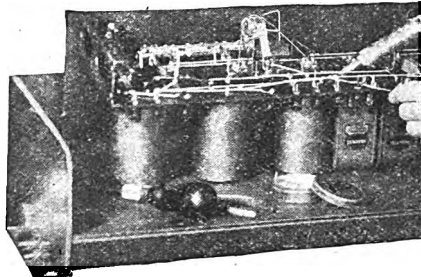
With a small outlay in money and a few hours work—following the instructions given in this article—you can build a receiver that you can boast about to anyone, both for its easy, selective operation and its astonishing quality of reproduction

By KENNETH HARKNESS

THE theory and design of my latest receiver, the Counterfonic, have been described in an article appearing in the December, 1927, issue of this magazine. In this article Mr. Dorf explained the features that I have strived to bring into actuality—simple construction, easy tuning, high quality of reproduction, and, last but not least, low cost.

I believe that with the carefully worked out panel arrangement for the assembly of the high-frequency and low-frequency circuits, the construction of this receiver is a relatively simple job.

As for sensitivity, the amplification per stage is closely tied up with the high efficiency of the balanced circuits incorporating the new method of cylindrical coil shielding. As for the quality of reproduction, the new Hiler double-impedance amplifier takes care of this point very completely through its novel method of tuning, as explained in a previous article by Mr. Dorf.



A JOB THAT THE BEGINNER CAN COMPLETE

The soldering of the connections on the Counterfonic becomes an astonishingly easy job, by reason of the extreme simplicity of the wiring. Nearly all the wires are run under the sub-panel.

Although the parts used in the new Counterfonic receiver are of excellent quality in both design and manufacture, the completed receiver costs but a fraction of the sum necessary to obtain a manufactured receiver that would give comparable results.

As a résumé of the design, the receiver includes two stages of high-frequency amplification, a vacuum valve detector and three stages of low-frequency amplification equipped with an

output filter for handling the large volume and for assuring the excellent tone quality of which the set is capable. The tuning is done completely with the single drum dial that operates the three-gang condenser. The only other controls I have incorporated in the design are a rheostat for the filaments, an "on" and "off" switch and an antenna switch for changing selectivity.

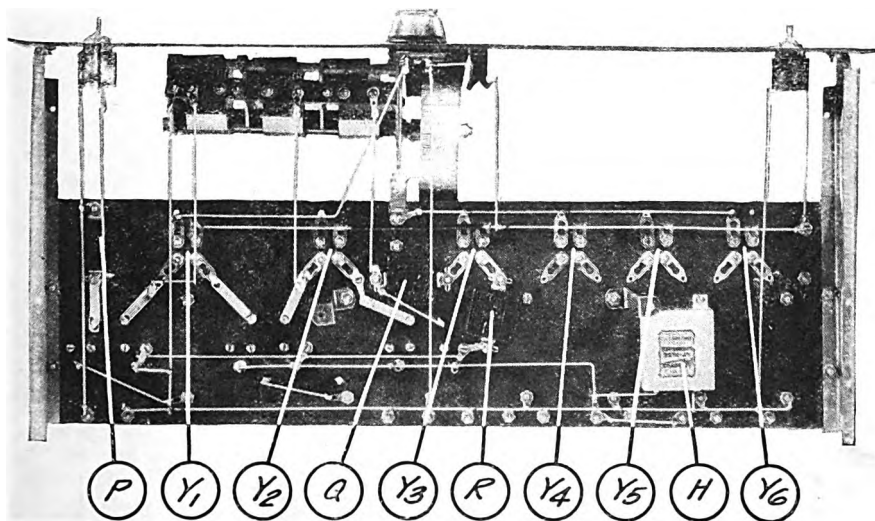
The schematic wiring diagram for the Counterfonic Six is shown in Figure 4.

How to Assemble the Instruments

It is best to start mounting the parts that are to be attached to the sub-panel, L. Fasten down the three high-frequency transformers, A, B and C, with two screws to each instrument, and then attach the three cylindrical copper shields, D1, D2 and D3, also by means of two screws apiece.

Then mount the two neutralizing condensers, U1 and U2, with two screws and nuts to each instrument. The three double-impedance couplers, E1, E2 and E3, and the output filter unit, F, should next be attached securely. These are also to be held with two screws and nuts.

Next mount the twelve binding posts, V1, V2, V3, V4, V5, V6, V7, V8, V9, V10, V11 and V12, in position, as indicated in Figure 3. The grid-leak mounting, T, may also be fastened on

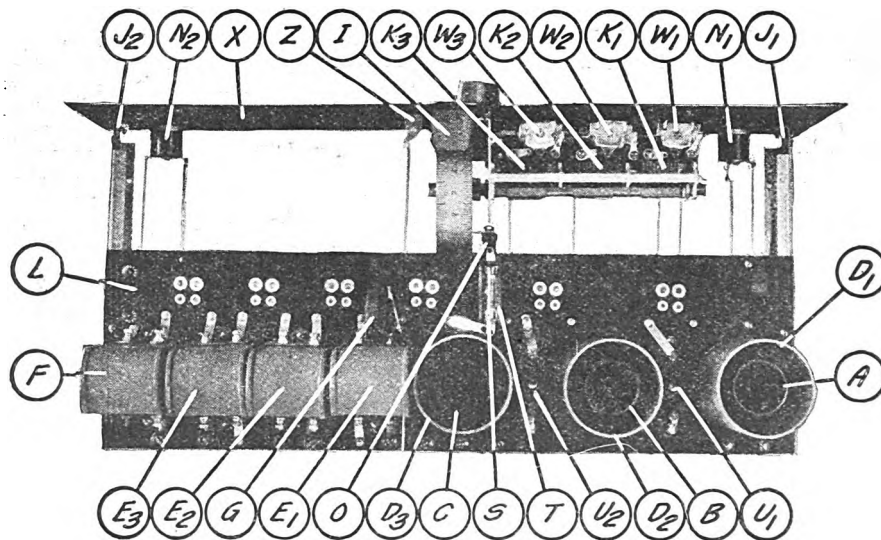


THE RECEIVER FROM BENEATH

FIGURE 1: The valve sockets across the center of the sub-panel come ready mounted on the drilled panel; this saves much of the assembly work. The only instruments mounted under the sub-panel are condensers H, P, Q and R.

POPULAR RADIO WORK SHEET

THE COUNTERFONIC SIX



THE LAYOUT OF THE INSTRUMENTS

FIGURE 2: Note the individual shields of heavy copper tubing around the high-frequency and detector stages at the right.

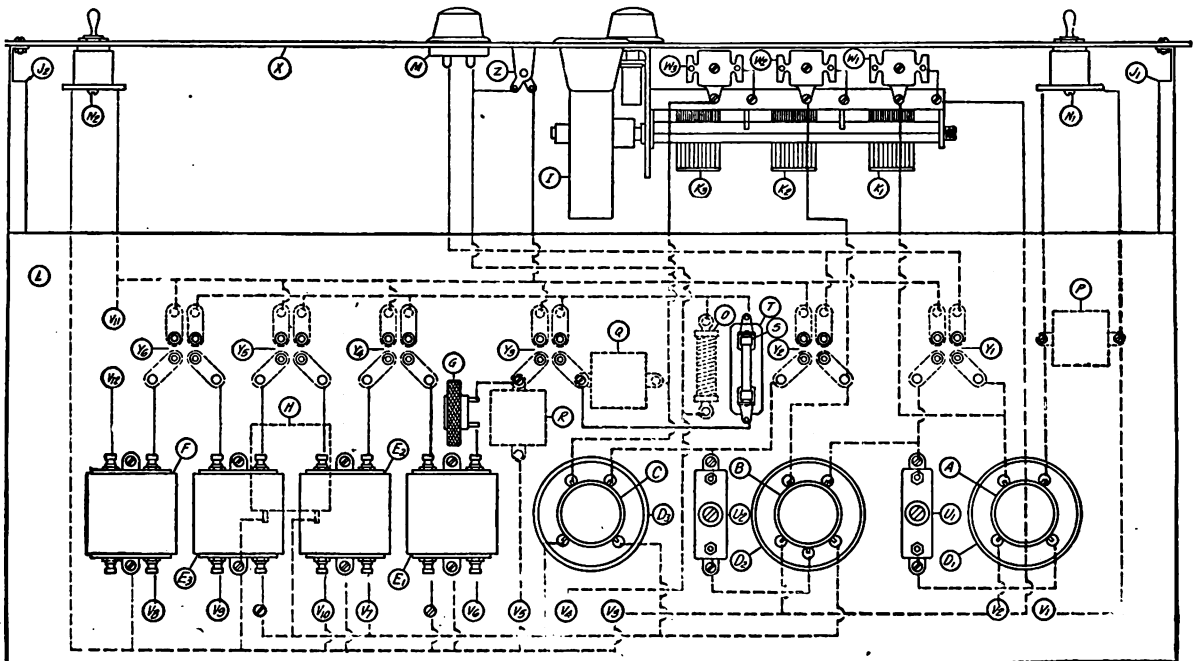
LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$60.00

A, B and C—Harkness Counterfonic high-frequency transformers;
 D1, D2 and D3—Cylindrical copper shields;
 E1, E2 and E3—Harkness tuned double-impedance audio-couplers for the first, second and third stages;
 F—Harkness audio-output-filter unit;
 G—Harkness high-frequency choke coil;
 H—Aerovox by-pass condenser, 1 mfd.;
 I—Silver-Marshall drum dial;
 J1 and J2—Harkness brackets;

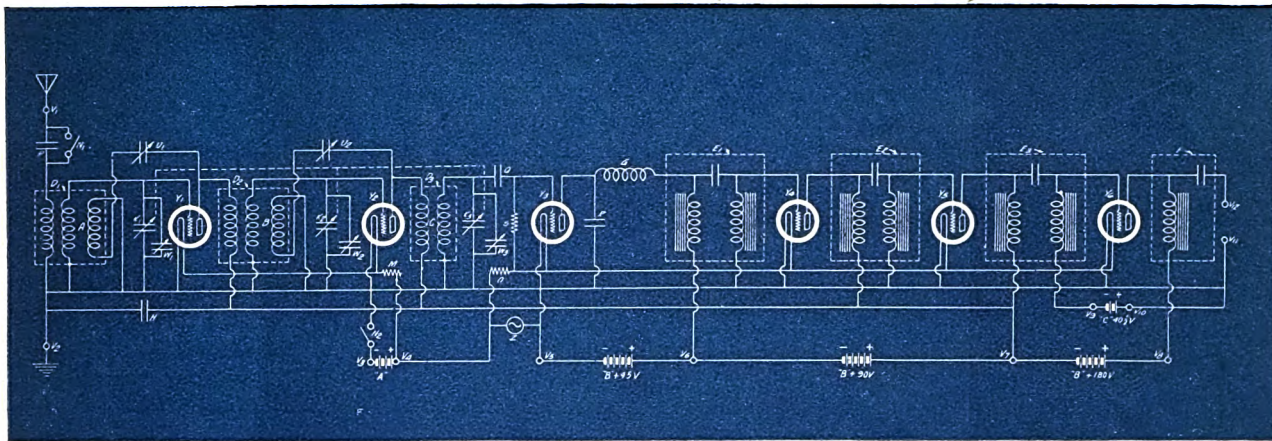
K1, K2 and K3—U. S. L. three-gang variable condenser, .00035 mfd. capacity in each section;
 L—Westinghouse Micarta drilled sub-panel, with six sockets attached;
 M—Carter midget rheostat, 10 ohms;
 N1 and N2—Saturn battery switches;
 O—Carter fixed filament resistor, 4/5 ohm;
 P—Aerovox fixed condenser, .0001 mfd.;
 Q—Aerovox fixed condenser, .00025 mfd.;

R—Aerovox fixed condenser, .001 mfd.;
 S—Lynch grid-leak, 2 megohms;
 T—Lynch grid-leak mounting;
 U1 and U2—L neutralizing condensers, .0001 mfd.;
 V1, V2, V3, V4, V5, V6, V7, V8, V9, V10, 11 and 12—Eby binding posts;
 W1, W2 and W3—Hammarlund equalizing condensers;
 X—Westinghouse Micarta drilled and engraved front panel.
 Wire, screws, solder, etc.



THE PICTURE WIRING DIAGRAM

FIGURE 3: Solid RED lines indicate the wiring above the sub-panel, dotted RED lines the wiring beneath. The instruments are outlined in BLACK.



THE SCHEMATIC WIRING DIAGRAM

FIGURE 4: Note the three windings in the first two high-frequency coils; the third winding in each case is for the purpose of neutralization. The double-impedance, low-frequency amplifier is at the right.

the sub-panel at this time. These are all of the instruments mounted on the top of the sub-panel, L.

Turn the sub-panel over and mount, with suitable screws and nuts, the three mica fixed condensers, P, Q and R, in their proper positions, as shown in Figures 1 and 3. Then fasten down the by-pass condenser, H, as shown in these same illustrations.

The filament resistor, O, may be fastened at one end by a screw and nut to the sub-panel on the underneath side.

When this is done, fasten the two brackets, J1 and J2 with two screws on each bracket to the sub-panel, L.

To start with the front panel, X, first mount the three Hammarlund equalizing condensers, W1, W2 and W3, on the 3-gang condenser, K1, K2 and K3. It will be noticed that each is fastened to the screw that holds one side of each stator of the triple condenser. The other side of these small condensers should be soldered by means of a lug to the screws that connect to the common frame of the triple condenser. This is shown clearly in Figure 3. Attach the bracket of the drum dial, I, to the condenser, K1, K2 and K3, and then attach the drum itself to the condenser shaft. The complete unit may then be mounted on the front panel, X, with two screws.

Next fasten onto the front panel, with two small screws, the window of the drum dial, I, including the dial light.

Next attach the midget rheostat, M, which is a single-hole mounting instrument. Then mount the two switches, N1 and N2, in the two corners of the front panel.

The sub-panel may then be attached to the front panel by means of four screws inserted through the holes in the front panel and the holes in the ends

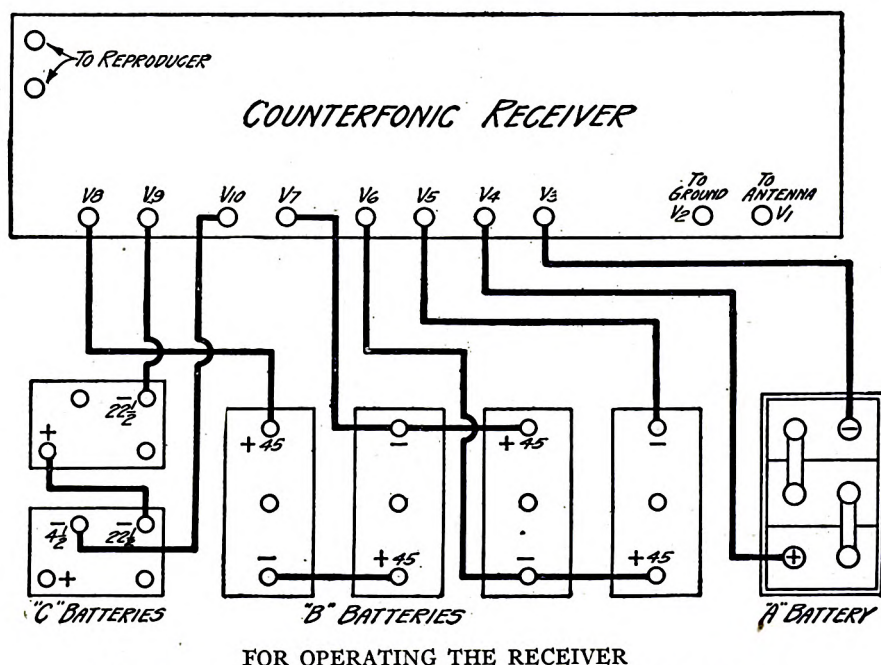
of the two brackets, J1 and J2. Flat-head machine screws and nuts should be used for this purpose.

This completes the construction work, except for the mounting of the high-frequency choke coil, G, which is supported by the wiring and may be done at that time.

Wiring the Counterfonic Six

As has been explained in the previous article, I have laid out this receiver so that the wiring may be accomplished in the easiest manner possible. The complete wiring to the low-frequency coupling units may be done by means of small strip connections, which are furnished as part of the complete kit.

I recommend for this particular receiver that all other connections be made with tinned, round busbar. Refer constantly to the picture wiring diagram in Figure 3 for the exact connections that are to be made to all of the instruments, parts and binding posts. This diagram carries out the theoretical circuit shown in Figure 4. In the picture wiring diagram all of the instruments are outlined in black and the instruments outlined in dotted black lines indicate those parts that are mounted underneath the sub-panel. The wiring itself is shown in red and the parts of the wiring to be done underneath the sub-panel are shown in dotted (Continued on page 72)



FOR OPERATING THE RECEIVER

FIGURE 5: The binding posts on the back of the Counterfonic sub-panel should be connected to the batteries indicated in this diagram. The two terminals marked "To Reproducer" are those lettered V11 and V12 in Figure 3.



CHECKING THE PILOT FOR HUMS

Among other tests at the POPULAR RADIO Laboratory, the Pilot power-pack was subjected to the test shown above, in which the unit was run under varying current loads, and the output tested for AC hum under these conditions.

A UNIT WITHIN THE REACH OF ANY POCKETBOOK—

The Pilot "BC" Power-Pack

If you have been forced to stick to battery operation for your receiver through the lack of sufficient money to buy a power-pack, all your troubles will be solved by the unit whose construction is described here. Although it employs only parts of tested excellence and durability, its cost is almost unbelievably cheap for a "B" power unit. It is especially adapted for use with AC valves.

By M. B. SLEEPER

SUCH strides have been made in the design of "B" power-packs that set builders are now able to make a unit that will supply voltages for operating their receivers at a very low cost, and without fear of breakdown. The unit described here will operate any standard receiver, giving voltages for power-valve operation in the last stage of a set, and intermediate voltages for the high-frequency stages and the detector, as well as a "C" biasing voltage and filament current for the power valve.

The new unit is designed for use with resistance or impedance-coupled amplifiers as well as with transformer types. It is designed to operate without "motor-boating" or other distortion with these standard amplifiers.

One of the special features of the unit is the method of ganging up paper filter condensers for the filter circuit. The condensers are placed side by side and long threaded rods are furnished with cross bars that mount all of the condensers as a single unit.

An idea of the simplicity of this new unit that uses the standard QRS rectifier valve may be gained from a study of Figure 1, which shows the top view of the unit with all of the instruments and parts mounted on a wooden baseboard, and with the binding-post strip running along the left end.

How to Mount the Parts

First of all, cut out the wooden baseboard, K, to a size of 6 inches by 14

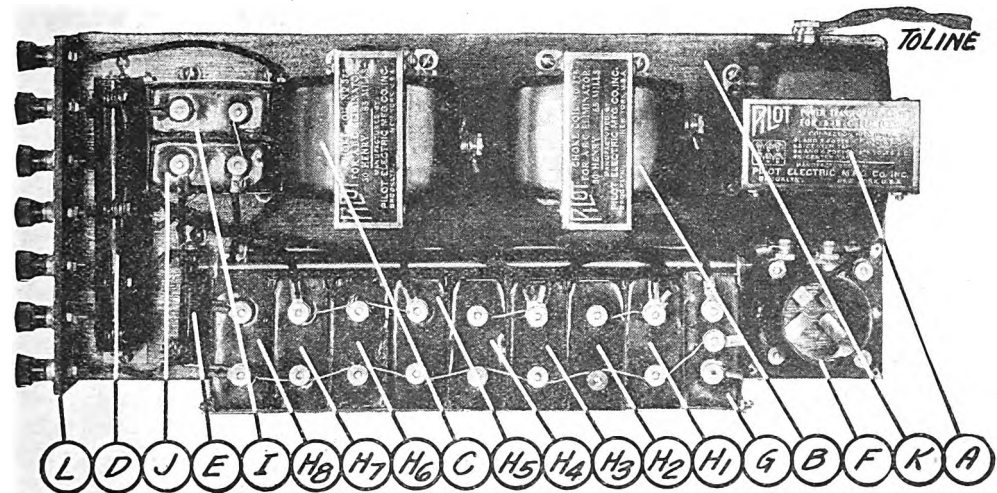
inches by $\frac{3}{4}$ inch. Finish it smoothly and give it a coat of shellac or stain. Next prepare the binding-post strip, L, as shown in Figure 3, and fasten on the seven binding posts, M1, M2, M3, M4, M5, M6 and M7. These are fastened by means of a nut tightened on the threaded portion of each binding post after it has been inserted through the connection strip. Mount the connection strip by three screws fastened through the three holes in the strip and into the end of the baseboard, K.

Next mount the two resistors, D and E, with round-head wood screws, driven into the baseboard. Then mount the two condensers, J and I, as shown in Figures 1 and 2. Do like-

(Continued on page 64)

POPULAR RADIO WORK SHEET

THE PILOT "BC" POWER-PACK



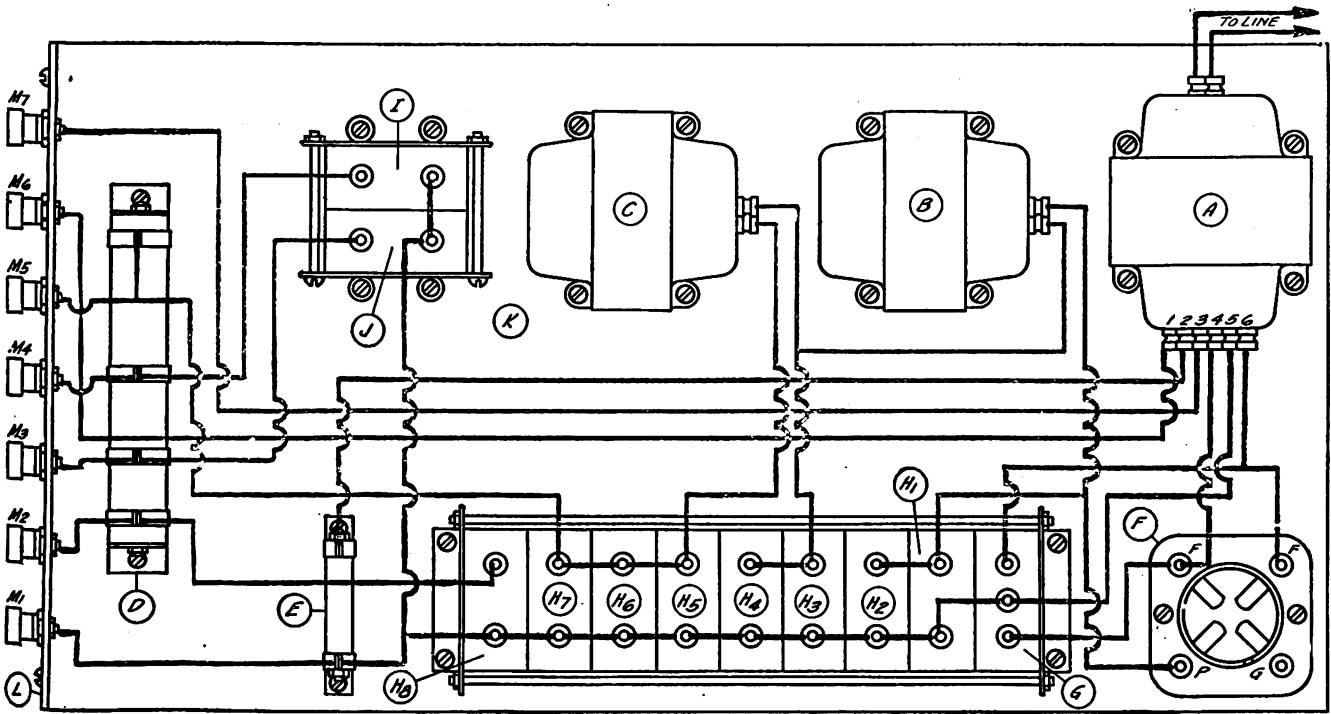
A VIEW OF THE UNIT FROM ABOVE

FIGURE 1: The condenser bank in the lower center of the illustration is made up of individual units assembled and clamped together with rods. The power transformer and rectifier valve are at the right.

LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$26.00

- | | | |
|---|---|---|
| A—Pilot power transformer, No. 374; | G—Pilot buffer condenser, .1 mfd. and .1 mfd., center tapped; | L—Bakelite connection strip, 2 by 6 by 1/8 inch; |
| B and C—Pilot choke coils, No. 375, 30 henrys; | H—Pilot high-voltage condensers, 2 mfd., with mounting rack; | M—Pilot binding posts, 2 plain, 2 "B" positive (+) amp., 1 "B" positive (+) det., 1 "A" positive (+) batt., 1 "A" negative (—) batt.; |
| D—Pilot wired resistor, 2,420 ohms, tapped at 1,200, 750 and 470 ohms, No. 952; | I and J—Pilot by-pass condensers, 1 mfd., with mounting rack; | Connection wires and lugs, nuts and bolts, screws. |
| E—Pilot wired resistor, 2,250 ohms, No. 951; | K—Wooden baseboard, 6 by 14 by 3/4 inch; | |
| F—Pilot socket, No. 201; | | |



AN ABOVE-PANEL WIRING JOB

FIGURE 2: The RED lines indicate the wiring; the instruments are outlined in BLACK. All the instruments are mounted and wired above the baseboard.

KILLING INTERFERENCE BEFORE IT IS BORN

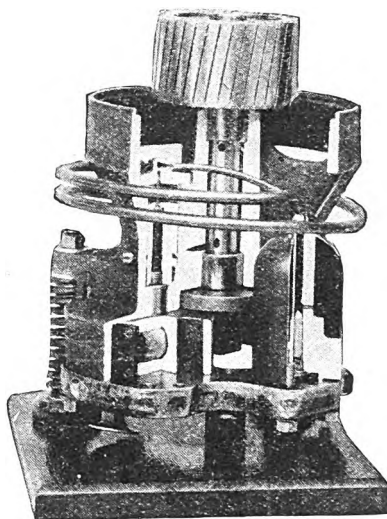
How the big electrical manufacturers are coming to the aid of the broadcast listener by eliminating interference-producing parts from electrical appliances for the home.

By AUBREY DELACY

THERE are hundreds of thousands—yes, millions—of electrical devices operating in the United States today with interference built right into them. They are a chronic and prolific source of electrical disturbance, for they were brought into the world of electrical appliances handicapped with these weaknesses. The day of electric eugenics has at last arrived, however, and in the future the engineering fathers of electrical devices will take care to see to it that no apparatus is reared from the laboratory to the practical stage without first having been correctly conceived.

The large electrical manufacturers of the United States, conscious of their obligation to the six million receiving set owners, have at last engaged in a plan to eliminate interference by so designing electrical apparatus that it will not be able to set up ethereal disturbances. It has been known, for instance, that electric heating pads with thermostatic controls have, in the past, caused a great deal of radio interference. The Westinghouse Company, realizing the devastating influence of such a device, set its engineering department to work on a heating pad with automatic control that could not cause any interference whatever. Its radio teeth were completely extracted, and it will be but a matter of time before other manufacturers of similar appliances will have to do precisely the same thing.

What the Westinghouse Company has done with heating pads the General Electric Company has done with ice box refrigerator units, which, incidentally, are invariably electrically controlled and driven. The illustration shows a refrigerator unit which has had its interference kinks ironed out successfully before it was placed in operation. The motor used is commutatorless, being of the induction split phase type. So carefully has the manufacturer of this equipment considered the possibilities of radio interference, and so successfully has that been eliminated, that a superheterodyne may be operated within a few feet of the contrivance



A REFRIGERATOR UNIT THAT CANNOT SPUTTER

The unit in the above picture is a cut-away model of the new refrigerator units that the General Electric Co. is employing in their electric refrigerators. By using an induction motor the interference produced by dirty commutators is completely eliminated.

without the slightest indication of hum or disturbance.

One of the large electrical manufacturers is submitting all of its power devices to its engineering department as a final check on the design of the apparatus from the standpoint of producing radio interference. It has been found, oftentimes, that the radio engineers when checking over these devices can offer suggestions which will reduce or practically eliminate any interference that might be caused.

The whole electrical industry is responding to the call to eliminate electrical interference, and, within a few years' time, practically all electrical appliances offered for sale will be "radio proof."

The greatest source of interference that must be overcome is that of electric sparks and arcs, and while the problem seems almost insurmountable at the present time, perhaps some genius will discover a way to eliminate this undesirable factor. When he does, he will be hailed as a bringer of peace and security to the world of radio reception, for 70 per cent. of the interference that we now have is caused by sparking devices. If the sparks are small enough they can be absorbed by condensers; but if they are too large to be handled in this way, nothing can be done until some other means of elimination is found.

The action of the big manufacturers in striving to create better conditions for radio reception is a good indication of the marvelous strides that radio has made during the past years. It shows that the world has come to recognize that radio has emerged from its infancy and is taking its place among the important activities of our planet, and is demanding its own "place in the sun." And such progress has been made so far that it is entirely possible that we may live to see an "interferenceless world." The human ingenuity that is able to devise radio will surely not be balked by the problem of eliminating the man-made interference of apparatus devised in pre-radio days.

14 Worst Offenders

1. *Sparking Motors.*
2. *Elevator Circuit Breakers.*
3. *Third Rails.*
4. *Arc Lights.*
5. *X-rays.*
6. *Ultra Violet-ray Machines.*
7. *Automatic Telephones.*
8. *Electric Sign Switches.*
9. *Precipitating Apparatus.*
10. *Automatic Heating Pads.*
11. *Toy Trains.*
12. *Electric Railroads.*
13. *Power Leaks.*
14. *Ozonators.*



The virtues of resistance coupling are fully realized when the LC-28 high-frequency pack is connected up with the National unit. The standard Corbett console cabinet of the LC-28 provides ample space for both the National unit and the "A" voltage supply.

A RESISTANCE-COUPLED AMPLIFIER FOR THE LC-28

Owners of LC-28's who put their trust in resistance-coupled low-frequency amplification will find exactly what they want in the new National power-pack amplifier. When used with the LC-28, the National unit supplies all the "B" voltages necessary for the high-frequency pack, and three stages of resistance coupling with a 210 type power valve in the last low-frequency stage.

By LAURENCE M. COCKADAY

RADIO fans who are enthusiasts for resistance-coupled amplification will be interested in this article, which announces a new resistance-coupled power amplifier that may be used with the LC-28 high-frequency packs.

The unit, as shown in the accompanying illustrations, is completely contained in a neat metal-cabinet that may be placed in the lower portion of the radio console which houses the LC-28, or in the compartment of the radio table.

It consists of two stages of resistance-coupled amplification, followed by a resistance-coupled power stage utilizing a large power valve of the 210 type. The first stage uses a high-mu valve and the second stage uses a standard type amplifier valve.

This unit will supply the total "B" power necessary for the LC-28 high-frequency pack, as well as for the self-contained amplifier. When this unit is used with the LC-28 high-frequency

pack, quite startling reproduction results may be obtained. The maximum volume is greater than necessary, although it may be controlled to a whisper, and the quality is of that high order that may be obtained from a correctly designed and manufactured resistance-coupled amplifier.

There are two variable adjusters on the unit for the intermediate "B" voltages.

In the picture at the beginning of the

article is shown one of the amplifiers being installed in the Corbett console for the LC-28 receiver. Once this has been set up and connected, it needs no further attention.

The Installation of the Amplifier

In using one of these new units in connection with the LC-28, it is recommended that the connection scheme shown in the combination diagram in Figure 1 be followed closely.

First the LC-28 set is placed in either the Corbett cabinet or the console. For simplicity's sake the rear view of the set is shown in Figure 1 installed in the cabinet. At the extreme right is shown the connection for the socket antenna connected to the antenna jack of the set. This combination will work very satisfactorily without an outdoor antenna, although the regular outdoor antenna may be used if desired. The ground wire should be installed and inserted in the ground jack on the set, as shown. Then the power-pack amplifier should be equipped with the necessary vacuum valves. The valves are placed in the sockets by turning the amplifier on its side, and in the first socket (on the left) a 240 type high-mu valve should be used. In the second socket place a type AX Ceco valve, and in the third socket place a type L-10 valve. Put a type R-81 rectifier valve in the last socket. Then turn the amplifier in its normal position and

install it in the compartment of the radio table upon which is set the receiver cabinet, or in the bottom part of the console, if one is used. The connections between the colored wires of the Yaxley cable should be made exactly as shown in Figure 1, with the red and black wires also running over to the "A" battery through the knife switch and the Yaxley relay. The cone reproducer, shown in the diagram, should be connected to the two output jacks at the left of the binding-post strip, on the amplifier. It is recommended that a Belden extension cord be used at this place so that the reproducer may be installed on the opposite side of the room from the receiver.

The AC extension cord and plug from the amplifier should be inserted in the socket on the Yaxley switch marked "B" Eliminator, and the extension cord and plug of the Yaxley switch should be inserted in a nearby 110-volt, 60-cycle lighting receptacle. The switch on the receptacle may be left turned "on" at all times.

If desired, a trickle charger may be connected in combination with the storage battery, and its extension cord and plug should be inserted in the socket on the Yaxley relay marked *Trickle Charger*.

The trickle charger arrangement is not shown in the diagram.

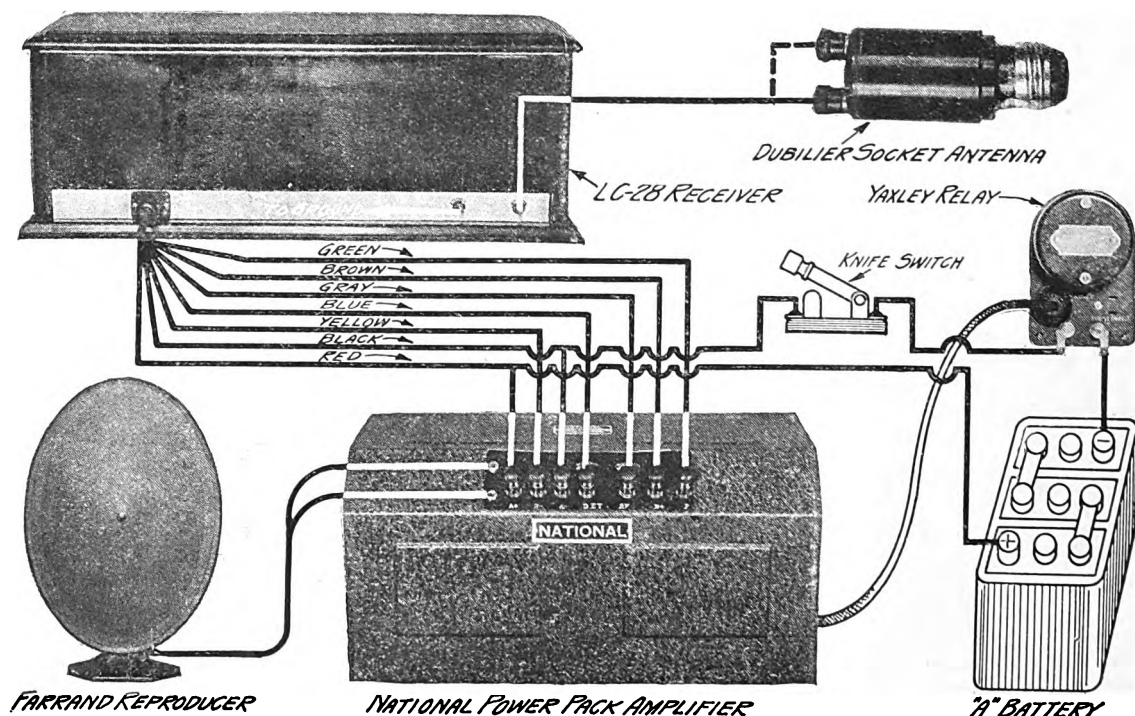
The knife switch that is shown in the diagram is used to turn the set "on"

or "off," and the switch rheostat on the LC-28 set itself is left "on" at all times. When the knife switch is closed, current flows through the Yaxley relay, the valves in the set, and two of the valves in the amplifier, thus causing the relay to operate and closing the line of the 110-volt circuit in the amplifier. This causes the rectifier valve and the power valve in the amplifier to light, thus furnishing complete "B" power to the set and to the amplifier itself.

This complete installation may be made in approximately fifteen minutes, and when once installed needs no further adjustment except the two controls for the proper high-frequency and detector plate voltages. These are made on the amplifier with the set in operation and the two adjustments will be found directly above the binding posts marked *DET* and *RF*. If the trickle charger is also installed, the set requires no further care outside of filling the storage battery with distilled water two or three times a year.

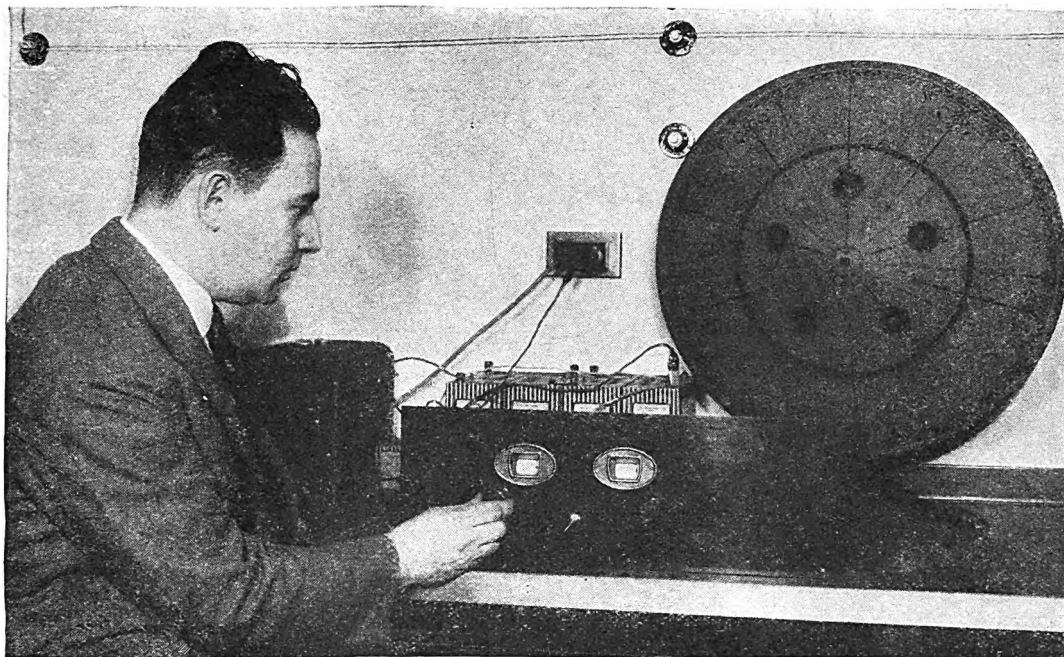
As stated before, the system of resistance-coupled amplification has many faithful adherents among the radio fans, and it is believed that this is the first opportunity offered to them to use a complete unit supplying power to the set and incorporating the highest quality resistance-coupled amplifier operated with a 210-type power valve.

(Continued on page 73)



HOW TO INSTALL THE NATIONAL UNIT

FIGURE 1: The hook-up shown above is one that has been tested and approved in the POPULAR RADIO Laboratory; if the units are connected as shown here the quality and volume obtainable should equal that of the finest manufactured set obtainable.



QUALITY RESULTS WITH A CRYSTAL

After the preliminary adjustment of the auxiliary controls, the operation of the New Home receiver is accomplished with the two tuning drums and the volume control knob.

CRYSTAL DETECTION GIVES AMAZING RESULTS IN *The New Home Receiver*

Here is a receiver that is designed especially for the fan who is anxious to get the best results with the most economy in operation. Although it uses only four valves, crystal detection and a careful design of the circuit give the New Home receiver a tonal quality and volume equal to that of many six-valve sets—at a much reduced drain on the “A” and “B” batteries, or on the power-pack, if one is used.

By WILL BRADLEY, JR.

IN describing the New Home receiver, it would perhaps be easier to answer, at first, two questions which will be raised in every mind. First, why use a crystal for a detector when vacuum valves are so much more sensitive; and second, how can four valves be used successfully when all of the latest factory-built sets call for at least five valves?

All of the new multi-valve sets depend upon high-frequency amplification before the detector, and in many instances the amplification is so great that the grid of this valve is sometimes biased to prevent overloading and consequent distortion. For this reason alone the use of a crystal is warranted, when it is preceded by sufficient high-frequency amplification. When we

further realize that the crystal cannot hiss, cause regeneration, or make any noise of its own accord, then its use becomes even more desirable.

Now, how many valves are necessary? If the set is to be located where a loop must be used, then eight valves seem to be the minimum that will be required, and the most satisfactory circuits will be the superheterodyne and the multi-stage tuned-high-frequency circuits; for on these installations we must also contend with the problem of extreme selectivity and sensitivity. In the suburbs and the country, where it is possible to erect an outdoor antenna, its use will enable us to pick up a vastly stronger signal impulse, and accordingly we can cut down on the high-frequency amplification, or the

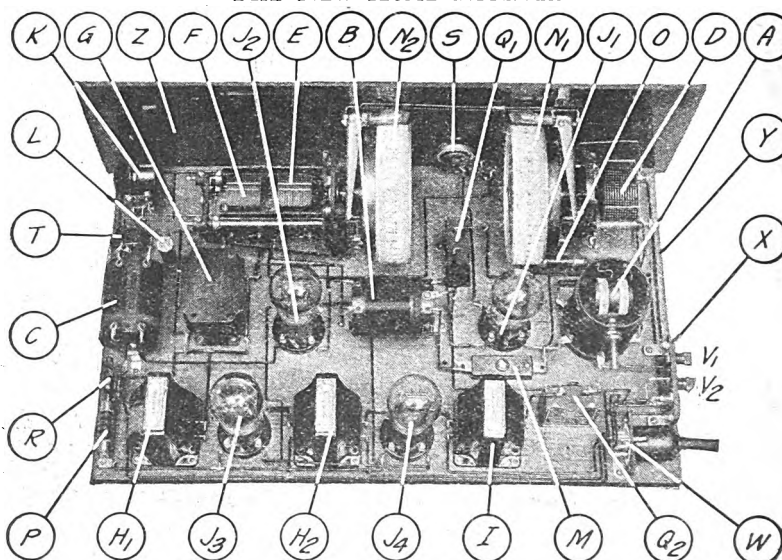
number of vacuum valves. When we consider that fewer valves will be much cheaper to maintain in service, because their demand upon “B” batteries and the “A” supply will be proportionately less, then the real value of as few valves as possible will be realized.

The New Home receiver has been developed after months of trial and is presented to POPULAR RADIO readers with these essential features:

1. Excellent tone quality;
2. Economy of operation;
3. Selectivity ample to meet the average need;
4. Sensitivity enough for distance reception when atmospheric conditions permit;
5. Easily tuned and logged;

POPULAR RADIO WORK SHEET

THE NEW HOME RECEIVER



THE RECEIVER VIEWED FROM ABOVE

FIGURE 1: For the best results the completed baseboard layout should have the neat appearance of that shown above.

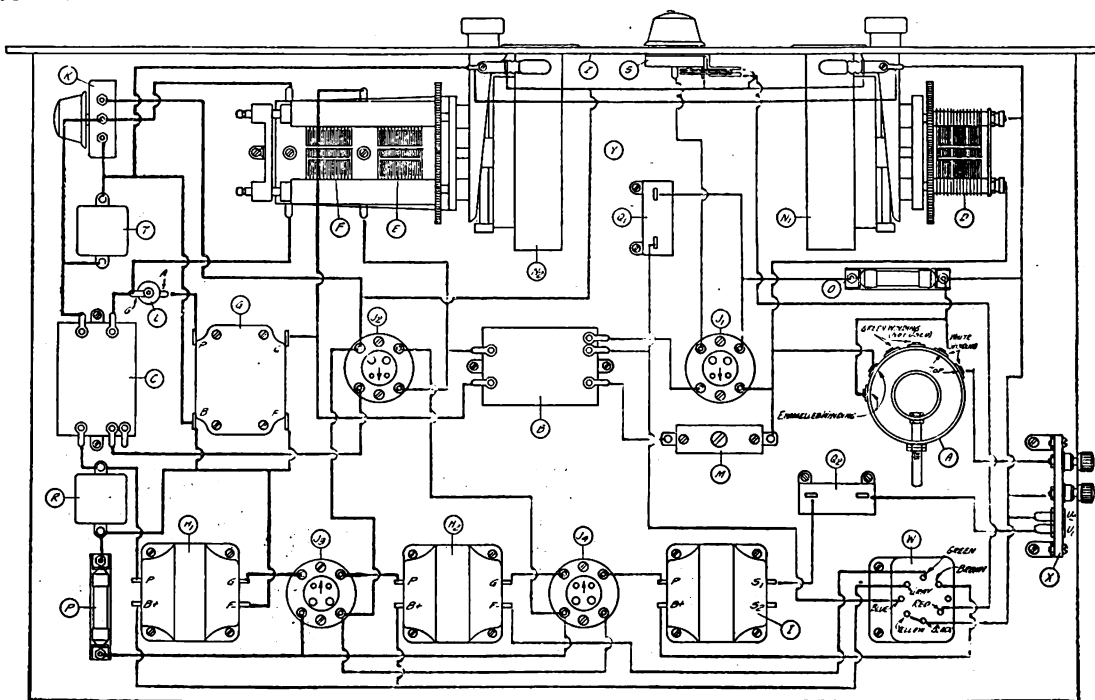
LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$70.00

A, B and C—One precision No. 3D 3-circuit tuner for .00035 mfd. condenser and 2 precision No. 4F tapped-primary coils; respectively;
D—Remler .00035 S. L. F. condenser;
E and F—Remler 2-in-line S. L. F. condensers;
G—AmerTran De Luxe transformer;
H1 and H2—Samson dual impedances, type D;

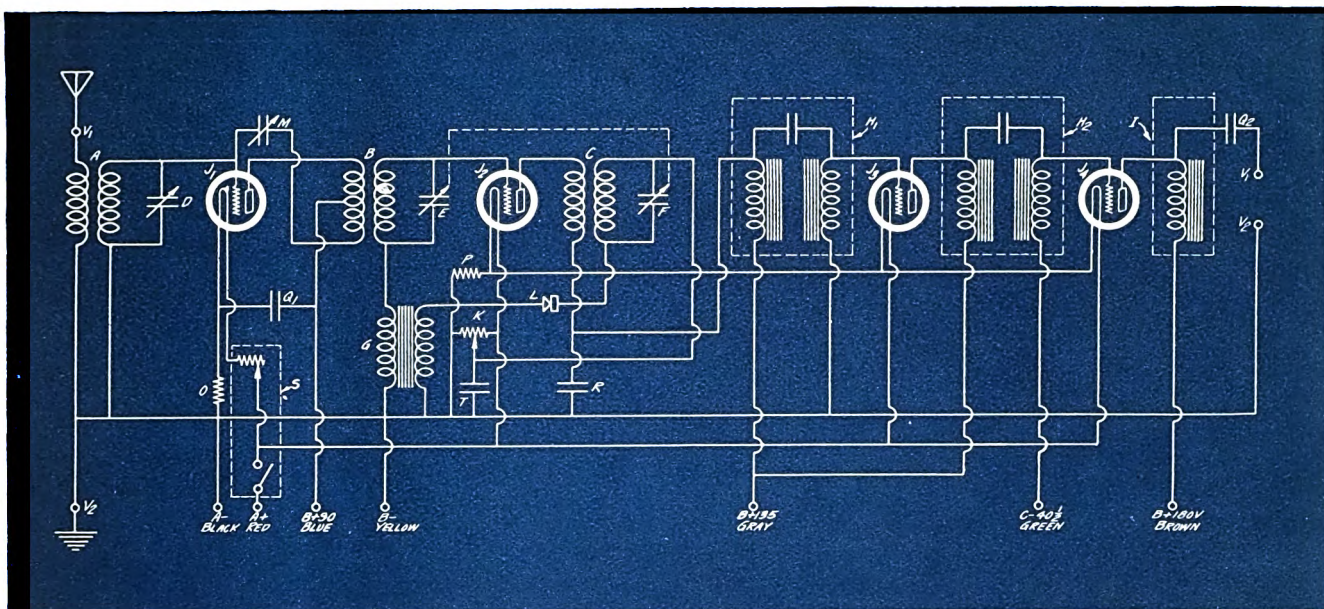
I—Samson output impedance, type O;
J1, J2, J3 and J4—Na-ald sockets;
K—Frost 2,000-ohm potentiometer;
L—Carborundum crystal;
M—X-L model N vario-denser;
N1 and N2—Remler drum dials;
O—Amperite, type 1A;
P—Amperite, type 4A;
Q1 and Q2—Polymet 1 mfd. filter condensers, type A;

R—Polymet moulded condenser, .002;
S—Carter 20-ohm rheostat and switch;
T—Polymet moulded condenser, .006;
U1 and U2—Yaxley pup jacks;
V1 and V2—Eby binding posts;
W—Yaxley No. 600 cable connector plug;
X—Binding-post strip, 1 by 3 inches;
Y—Baseboard, 20 by 12 inches;
Z—Panel, 7 by 21 inches.



HOW TO WIRE THE RECEIVER

FIGURE 2: The instruments are outlined in black; the wiring is all done above the baseboard, and is indicated in red.



THE CIRCUITS OF THE NEW HOME RECEIVER

FIGURE 3: The high-frequency amplifier is at the left in the schematic diagram; the double-impedance-coupled, low-frequency amplifier and output filter at the right. The crystal detector is shown at L, followed by the reflex transformer, G.

6. Readily converted to entire AC or DC operation;
7. May be used as a low-frequency amplifier for the new electric-cut records;
8. Absolute absence of regenerative howls.

The heart of this circuit is the carborundum crystal detector in combination with the AmerTran De Luxe transformer. Reference to Figure 3 will reveal the total absence of any bridging or by-passing condensers in this part of the circuit, that would otherwise impair the straight-line amplifying

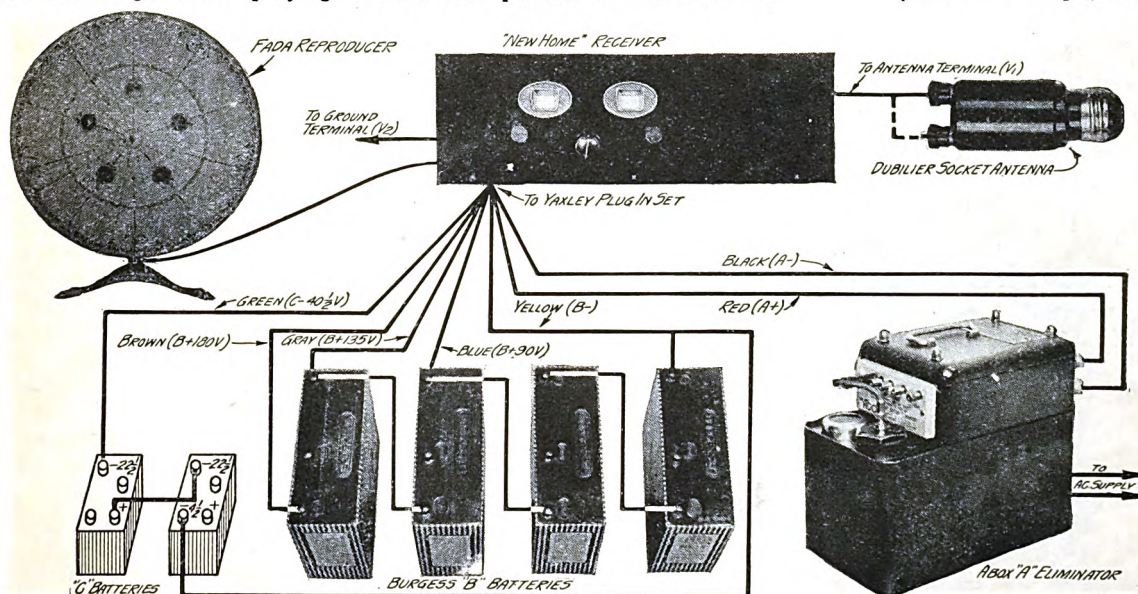
qualities of this excellent transformer.

Briefly, the circuit consists of two highly efficient stages of tuned-high-frequency amplification, a crystal detector, followed by a transformer and two double-impedance stages—in all, the equivalent of six-valve operation. In fact, all of the parts necessary for the construction of a six-valve set are included in this kit, with the exception of two sockets.

Through the careful plotting of the time and phase relations of the currents in the high-frequency end of the circuit, it has been possible to make the sec-

ond valve perform a double duty, that of amplifying two different frequencies with no impairing effect to either. At all times the valve operates on the correct part of its grid-voltage, plate-current curve. Looking back to the old method of controlling oscillations in reflex circuits by a potentiometer control of grid-bias, so detrimental to high-frequency efficiency, or by variation of the detector filament voltage, which seriously hurt the quality of reproduction, it is but small wonder that the once-popular reflex has lost favor. The New

(Continued on page 93)



AN EXCELLENT OPERATING COMBINATION

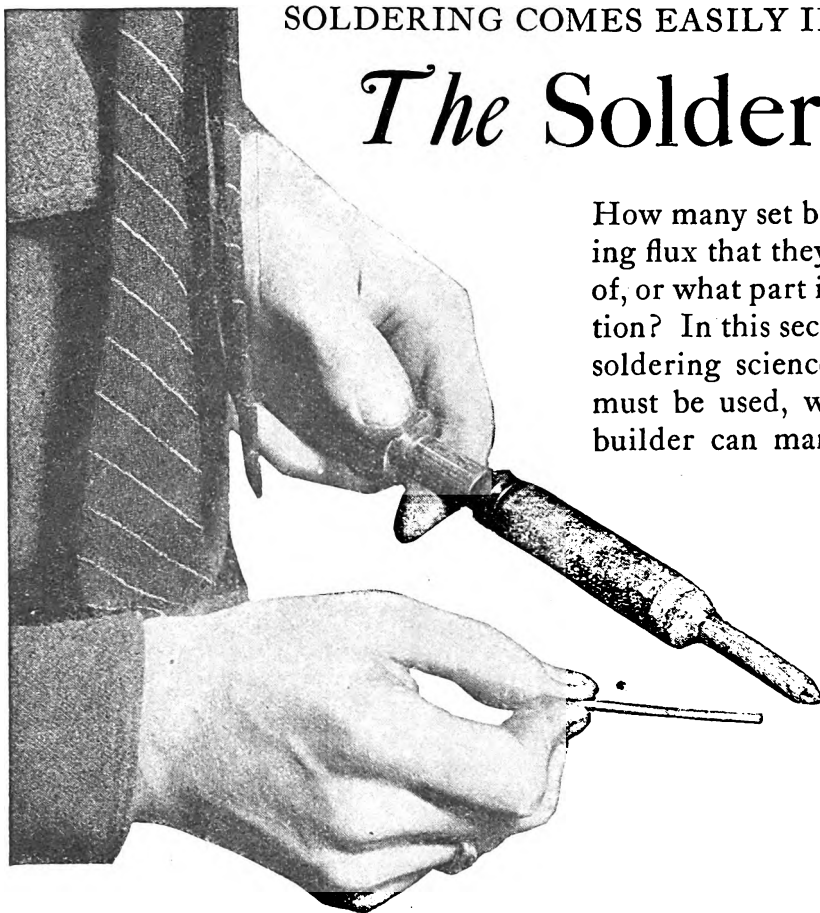
FIGURE 4: On account of its low current drain, "B" batteries may be employed quite economically with the New Home receiver. The socket antenna and "A" eliminator were also found very successful in this hook-up.

SOLDERING COMES EASILY IF YOU KNOW THE RULES OF

The Soldering Science

How many set builders know what the soldering flux that they use constantly really consists of, or what part it plays in the soldering operation? In this second article in the series on the soldering science, Mr. Ripley tells why flux must be used, what it does, and how the set builder can manipulate it most successfully.

By P. C. RIPLEY*



ALL unprotected metals in contact with the atmosphere acquire, on their surfaces, a more or less invisible film of oxide. This is the direct result of a chemical action produced by the attraction existing between the metal and oxygen. A common example of this action is the formation of red rust or ferric oxide on iron. Before uniting two dissimilar metals or two pieces of like metal with a bond of solder these oxides must be removed. This is accomplished with a de-oxidizer, more commonly termed a flux.

Suppose we take two metal parts having their surfaces covered with this film of oxide and we wish to solder them. A careful inspection may disclose the fact that matter other than oxides may lie upon the oxide formation, such as sulphates, chlorides, carbon particles (dust), gums (shellac, varnish, enamel, lacquer), or other compounds too numerous to mention. Flux is designed to dissolve metallic oxides and nothing else. The removal of matter other than oxides on radio parts must be accomplished in a mechanical way, for any chemical solvent with sufficient capacity to cope with this varied array of substances would

also violently attack the metal itself. The results of such an attack would likely be the formation of new compounds on the work whose removal would be more difficult than the original material encountered.

Too many who attempt to use solder have the delusion that a good flux is a magical substance in whose power it lies to dissolve and remove any and all matter with which it may be placed in contact. Let mechanical cleaning such as sandpapering, filing, or scraping be the means of disposition for such matter, offering the flux the opportunity to accomplish the work for which it is intended—oxide removal.

On certain metals, some fluxes develop their greatest capacity as oxide solvents at higher temperatures, while others must be utilized at lower ones. The safest, surest, and most satisfactory method to be followed when specific knowledge is lacking, is to bring the part to a solder-melting temperature; then apply the solder and flux to the surface where adhesion is desired. The flux attacks the oxides and dissolves them, presenting a clean surface on the metal parts for the reception of the molten solder. The solder in turn acts as a solvent, dissolving a small quantity of the clean surface of the

parts; and under the favorable and necessary condition which we have prepared by fluxing and cleaning, it actually alloys with these parts. Following the withdrawal of the soldering heat and the resulting solidification of the solder, we discover that the two metal parts are securely bonded.

Chloride fluxes come under the heading of the stronger fluxing agents and are efficient at oxide solvency. Practically all commercial fluid and paste forms of fluxes depend upon the activity of some chloride salt for their fluxing capacity. Fluxes of the fluid form are generally solutions composed of such solvents as alcohol or water into which have been dissolved varying amounts of zinc and ammonium chlorides. Pastes are emulsions formed from organic greases or waxes and chloride salt solutions. In both cases, the chlorides are the active constituent of the flux.

Residuals of the chloride fluxes are always more or less conductive, due to the activity of the zinc chloride at moisture collection; furthermore, it does not lose this quality from exposure to the temperature of soldering heats. A dilute solution of hydrochloric acid is an efficient conductor of electrical energy and such solutions are formed from the residual of chloride fluxes. Leakage is likely to result through this conducting medium. Such leakage will rob a receiving set of measurable signal strength, with the corresponding loss in volume and receptive range.

Let us visualize what takes place when chlorides are employed as a fluxing medium, either in a paste or fluid form. We will take for an example the soldering of a stranded conductor

(Continued on page 65)

*The author of this series of articles on the science of soldering, Mr. P. C. Ripley, is Chief Engineer of the Chicago Solder Co.

A New Discovery in Loudspeakers

The familiar cone and horn types of loudspeakers have, at last, a serious rival in this new type of reproducer that operates on the principle of "balanced tension" between two tightly stretched skins. So extraordinary have been the results with the Air-Chrome loudspeaker, which incorporates this principle, that great popularity is predicted for it by radio experts who have heard it

By CARL DORF

THERE are two general types of reproducers that have found wide popularity for radio broadcast reception—the cone type and the horn type. These are so generally known and understood that it is not necessary to go into explanatory details in the variations of these two types.

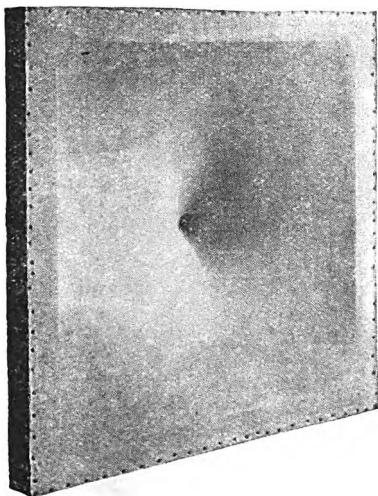
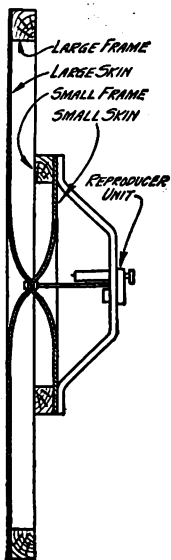
A third general type has recently been developed by W. B. Whitmore that bids fair to excel both these

types, on account of its possibilities and inherent qualities. This has been called the balanced-tension type of reproducer. It consists of two tightly stretched, but thoroughly flexible, skins of treated linen or other material, the center points of which are fastened together concentrically so that each one forms, in cross section, a hypercycloid, with the apexes of the two pointing towards each other. The two stretched

skins, as shown in the cross section drawing in Figure 1, are mounted on two frames, and the apex point of each is brought to a balanced position due to the tensions acting on the center point of each skin. To this center point is attached the pin of the reproducer unit.

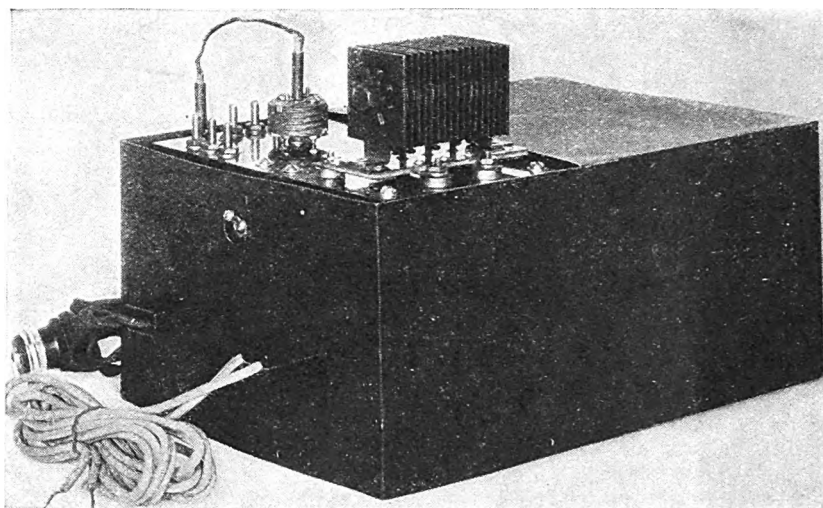
The large stretched skin is of the correct dimensions and stretched to the

(Continued on page 76)



THE WORKING PARTS OF THE NEW UNIT

FIGURE 1: At the left is a cross section of the unit, showing the two skins stretched on separate frames, with their center points drawn together and attached to the driving pin. In the center is a view of the large skin on its frame, and at the right is a view of the unit from the rear, showing the driving unit mounted on the small frame.



READY FOR INSTALLATION

FIGURE 1: The Knapp "A" unit is shown here with the shield in position over the working parts. The only exposed parts are the rectifier unit and the bakelite plug panel for varying the amount of current to suit the filament needs of the receiver.

WHAT RADIO FANS HAVE BEEN WAITING FOR—

"A" Power—Dry and Silent

One of the radio fan's most crying wants—an "A" power-pack that is efficient and silent in operation, that requires no attention and that can be assembled by a novice—is described here. It employs a new type of rectifier that requires no upkeep. The output current may be varied to suit the needs of from one to eight valves.

By CLIFFORD H. HAMILL

AN "A" power-pack for delivering enough current at the proper voltage to supply anything from a one to an eight-valve receiver and employing no vacuum valve rectifier is indeed an innovation in equipment of this type. Such is the Knapp "A" power unit, which has a low power input of 50 watts when operating an average eight-valve receiver. The rectifier unit is perfectly dry and has an exceptionally long life, while the operation of the complete unit is cool and efficient, due to liberally designed transformers and chokes. Special condensers involving a new principle and measuring only $6\frac{3}{4}$ by 2 by 2 inches supply the amazing capacity of 2,500 mfd., which gives perfect capacitive suppression of ripples without the least trace of a hum.

How to Assemble the Unit

For the convenience of the builder, the small parts of this kit set, including all the necessary hardware, bolts, screws, brackets, wire, etc., are placed in envelopes which are supplied with the kit and which are numbered from

one to sixteen. In the list of parts on the page opposite, the number of the envelope in which it is to be found is given after each item. That the ensuing description may not become unnecessarily involved, no further reference will be made to the hardware, it being assumed that the builder will locate this material from the markings on the envelopes.

A special base-plate made of coppered steel is supplied with the kit and on this there is mounted, by means of brass spacers or feet, the transformer, A. It will be noted from Figure 3 that the transformer is mounted so that its core is horizontal, while the choke coil mounted beside it is arranged so that its core is vertical. It will not be necessary to drill the holes for the machine screws, since the special base-plate is supplied with these holes already drilled. Both the transformer and the choke coil are supplied with brass spacers, which are used to support the bakelite connection panel or plate carrying the rectifier unit and the secondary connection taps. All of the dotted lines in

Figure 4 represent connections made underneath the panel and these connections should be made with the wire provided *before* the panel is put in place on the top of the unit. The terminals, 10, 11, 12, 13 and 14, in Figure 4 represent the special clamping screws of the binding posts which hold into place the rectifier unit, R, the latter being supplied with lugs to engage with the screws mentioned. The wiring to the rectifier should be done with No. 16 tinned copper wire which is covered with saturated sleeving.

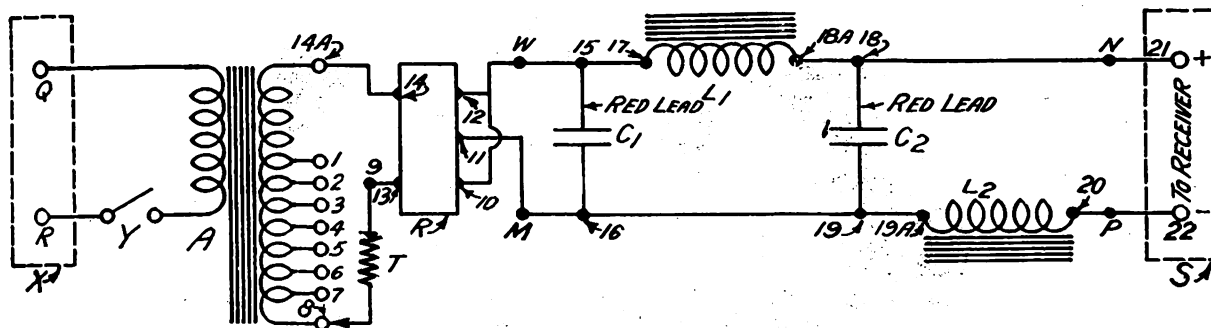
The secondary tap leads are now soldered to the secondary taps of the transformer and, in turn, connected with the corresponding binding posts, 1, 2, 3, 4, 5, 6, 7 and 8, in Figures 3 and 4. The transformer taps are designated with numbered paper tabs, so that there can be no mistake in connecting the right transformer tap to the corresponding connector on the panel.

The top plate should now be screwed into place, using the machine screws and washers supplied for this purpose.

(Continued on page 86)

POPULAR RADIO WORK SHEET

THE KNAPP "A" POWER PACK

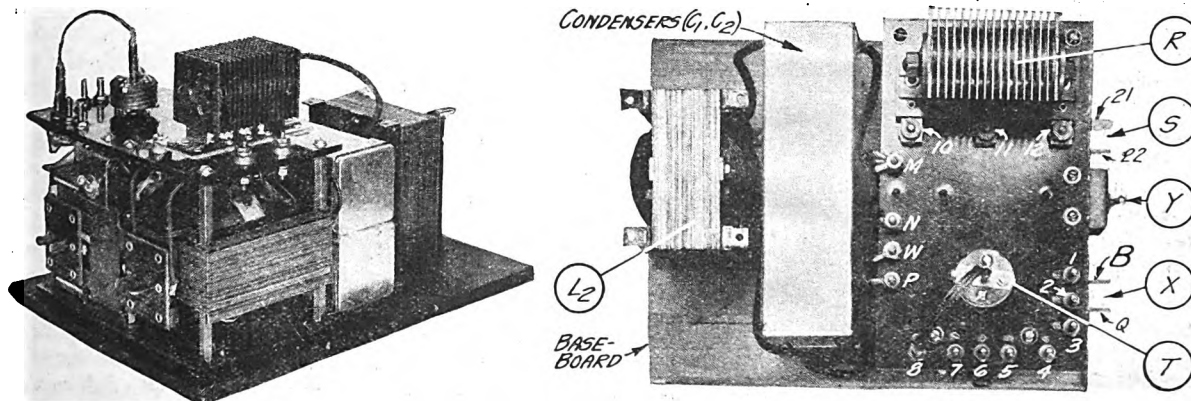


THE CIRCUIT DIAGRAM OF THE UNIT

FIGURE 2: The step-down transformer is shown at A, and the rectifier unit at R. To the right is the filter circuit that changes the pulsating output of the rectifier to pure DC. The numbers on the diagram are referred to in the text, and indicate exactly where each wire in the circuit should be connected.

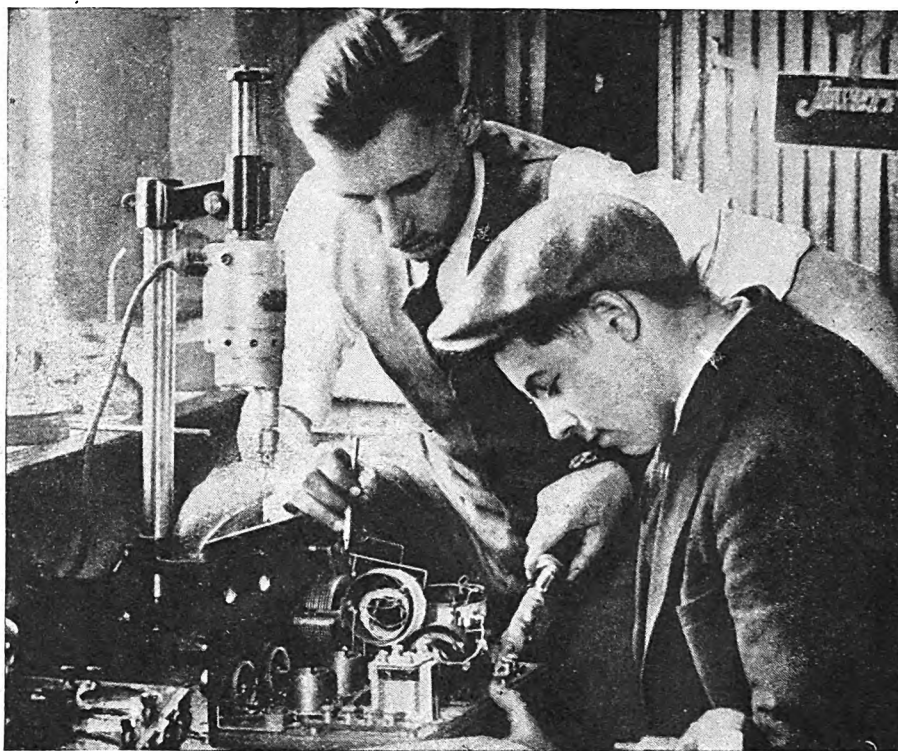
LIST OF PARTS FOR THIS UNIT

- | | |
|---|--|
| 1—Transformer with tapped secondary, A; | 16—Switch post nuts, envelope No. 4; |
| 2—Rectifier unit, R; | 17—Transformer to top plate hexagonal spacers with screws, envelope No. 5; |
| 3—Special high-capacity "A" power condenser, C1; | 18—Top plate mounting screws and washers, envelope No. 6; |
| 4—Choke coil with brass spacers, L1; | 19—Transformer secondary tap leads, envelope No. 7; |
| 5—Special high-capacity "A" power condenser, C2; | 20—Mounting board; |
| 6—Choke coil, L2; | 21—Shield; |
| 7—Top contact and switch plate (brown bakelite), with rubber-covered lead; | 22—Mounting brackets for condensers; |
| 8—Base-plate (copper-plated steel); | 23—Condenser bracket to mounting board wood screws, envelope No. 12; |
| 9—Input-output receptacles with mounting brackets, X and S; | 24—Mounting board to base-plate machine screws, envelope No. 11; |
| 10—H. & H. toggle switch, Y, envelope No. 8; | 25—Choke coil (L2) to mounting board wood screws, envelope No. 13; |
| 11—Resistance unit, T, envelope No. 10; | 26—Attachment cord with plugs; |
| 12—Switch post connector of braided copper, with receptacles, envelope No. 9; | 27—Six-volt output leads with polarized plug; |
| 13—Transformer mounting screws and nuts, envelope No. 1; | 28—Shield to mounting board wood screws, envelope No. 14; |
| 14—Choke coil (L1) mounting screws, envelope No. 2; | 29—Four feet of No. 16 tinned copper wire, envelope No. 15; |
| 15—Input-output receptacle bracket screws, nuts and washers, envelope No. 3; | 30—Three feet of No. 10 saturated sleeving for wire, envelope No. 16. |



TWO VIEWS OF THE NEW UNIT

FIGURE 3: At the left the Knapp "A" unit is shown with the shield removed to expose the component parts. Note the compact way in which the unit is assembled. At the right is a view of the unit from above, showing one of the chokes (L2), the top filter condenser, and the bakelite panel on which is mounted the rectifier, R, and the taps for varying the amount of filament current.



International Newsreel

EVERY TOWN NEEDS A SERVICE MAN

A reputation as a reliable service man may be gained by any industrious and conscientious radio fan among the set owners of his immediate neighborhood. Upon this may be built, as the author of this article built, a lucrative business in servicing, repairing and building radio sets in the community.

HOW I PUT SPARE HOURS TO WORK AND SUCCEEDED IN MAKING RADIO PAY

By JAMES A. ROBINSON

SIX months ago I was a bookworm using up all of my spare time without any thought of capitalizing on what I knew or what I could learn. Today, besides my regular means of employment, I have a bank account of substantial proportions; I have a car; I have approximately \$400 worth of radio merchandise in stock; I have a credit with the local dealer to the extent of \$1,000; I have radio tools and testing apparatus valued at \$150; and I have established good will and prestige in the community in which I live. This, I believe, is a rather enviable record for a man who had never before been in business for himself, and who was equipped with only the rudiments of business knowledge.

The whole thing came about through my studying and completing a course in radio construction offered by a radio correspondence school. Although the town I live in—Methuen, Mass.—has a population of but 12,000, I came to

It is estimated that no less than 30,000 alert young men are making anywhere from twenty to one hundred and fifty dollars a week constructing radio receivers for local use. Statistics seem to show that approximately ten million dollars a year is being expended for custom-built sets.

Mr. James A. Robinson, who knew little about radio prior to taking a correspondence course at the National Radio School, here tells how he built up a good business on small capital and large faith.

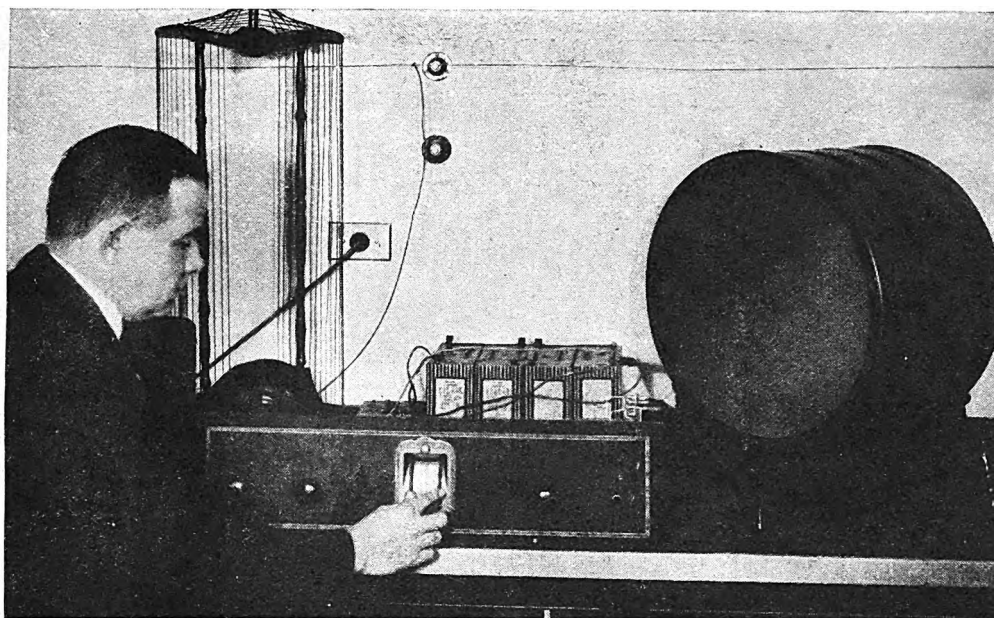
realize that even in such a small place there was great opportunity for a man who knew something about radio, and who could intelligently and efficiently service, build, and repair radio receivers.

The one obstacle to my whole plan of action, however, was the modest capital of \$75, which was all that I could afford to invest in the new venture at the time, since I was handicapped with a chronic illness in the family.

While I knew that there was radio business to be had, how was I to get it? I couldn't advertise, nor could I afford to spend a great deal of time in soliciting business. After giving the matter a great deal of thought, I finally concluded that perhaps the best way to do would be to work entirely on the basis of recommendation.

At the start, much of my work was done gratis. Being equipped with a

(Continued on page 69)



THE VICTOREEN IN OPERATION

The Victoreen is shown here operating with a loop antenna; however, one of the features of the new receiver is its adaptability to operation with other kinds of antennas, such as the light socket and outdoor types.

THOUSANDS OF FANS ARE BUILDING

THE VICTOREEN "SUPER"

Here is an eight-valve superheterodyne that incorporates all the latest ideas in radio construction and design, yet is as easy to assemble, wire and operate, as many an old five-valve set. But its tonal qualities rank it with the best that 1928 engineering will be able to produce.

By LESLIE BILES

PARADOXICAL as it may seem, the superheterodyne is probably the most praised and the most condemned circuit known to-day, and has probably caused more grief and a greater waste of money than any other circuit or combination of circuits. Yet, basically, the superheterodyne is one of the supreme circuits for radio reception.

It is not the hook-up alone that makes a good superheterodyne, for with the exception of the wiring of the oscillator there are few differences in the hook-ups of the various types of superheterodynes in use to-day. The basic circuit may be improved, or the parts may be arranged, with various numbers of intermediate-frequency stages of amplification, but the theory and scheme of all types are fundamentally the same.

Judging by past experience, however, it is safe to say that many superheterodynes that are built by radio fans are inferior to a good tuned-high-frequency or combination tuned-high-frequency

and original type of receiver. On the other hand, in a carefully designed superheterodyne there are certain outstanding features that make it superior, if the apparatus used has been properly designed, manufactured and tested, and if the mechanical arrangement has been laid out with a clear understanding of just what will happen in the circuits.

One of the outstanding features of the superheterodyne is its ability to get distance reception satisfactorily; in this respect it is superior to most of its rival circuits. And in spite of the tendency among fans in recent years to forget about distance reception in their interest in low-frequency apparatus and quality reproduction, it is the author's opinion that almost every fan at some time or other experiences a strong desire to own a receiver capable of bringing in programs on the loudspeaker from stations far away.

The set described in this article is not only designed to give high quality

of reproduction, but to have the necessary sensitivity and selectivity to enable it to tune through the locals and pick up stations at great distance.

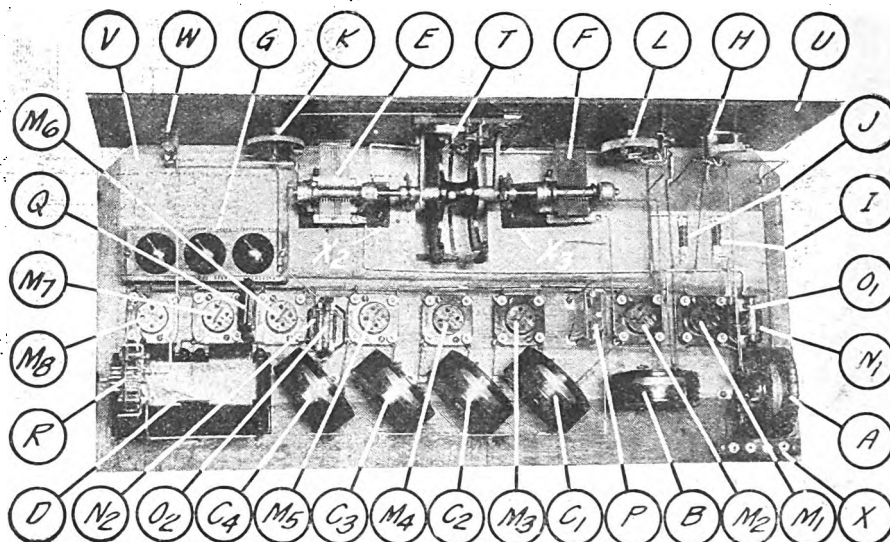
The circuit arrangement is such that it may be used with either a loop antenna or with an outdoor antenna by simply throwing the switch. The circuit contains an oscillator and first detector coupled together so that the frequency of the incoming signals may be lowered to the frequency of the three-stage intermediate-frequency amplifier. This is followed by a vacuum valve detector for rectification and two stages of high-quality, transformer-coupled amplification. Two transformers are incorporated in a single unit known as an audio coupler. The schematic circuit diagram for the receiver is shown in Figure 3.

How the Set Is Constructed

In building the set described in this article a rectangular section is cut

POPULAR RADIO WORK SHEET

THE VICTOREEN SUPERHETERODYNE



HOW THE INSTRUMENTS ARE MOUNTED

FIGURE 1: The simplicity of the arrangement of the parts makes this superheterodyne an easy one for the novice to attempt.

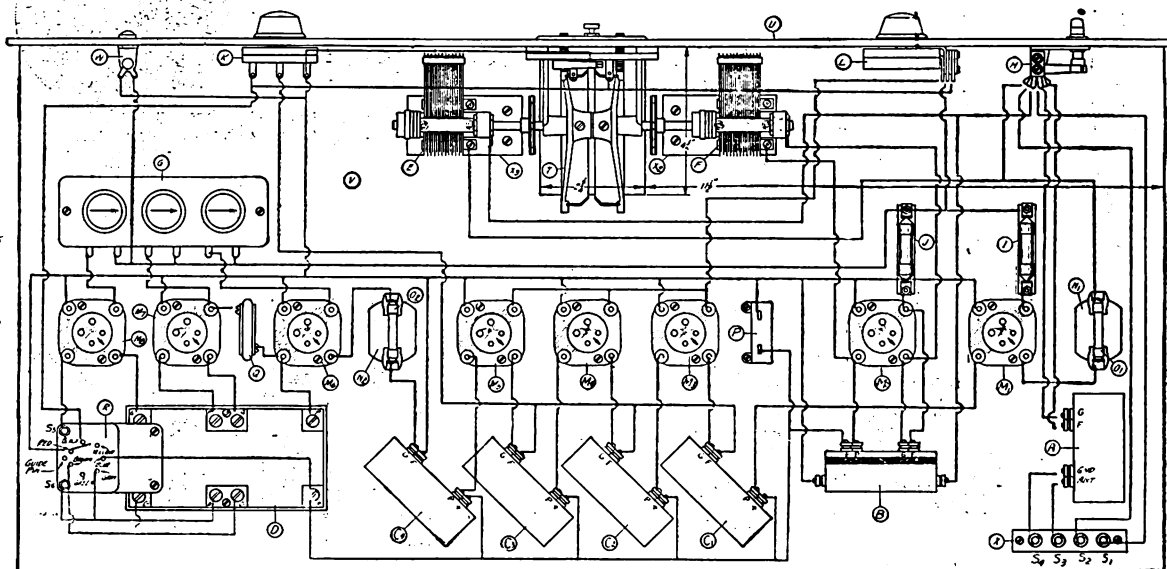
LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$110.00

A—Victoreen antenna coupler;
B—Victoreen coupling unit;
C1, C2, C3 and C4—Victoreen high-frequency transformers;
D—Victoreen audio coupler, type No. 112;
E and F—Hammarlund midline variable condensers, .0005 mfd.;
G—Victoreen audio control unit;
H—Yaxley double-pole, double-throw panel switch;
I and J—Amperites No. 1-a;
K—Yaxley potentiometer, 400 ohms;

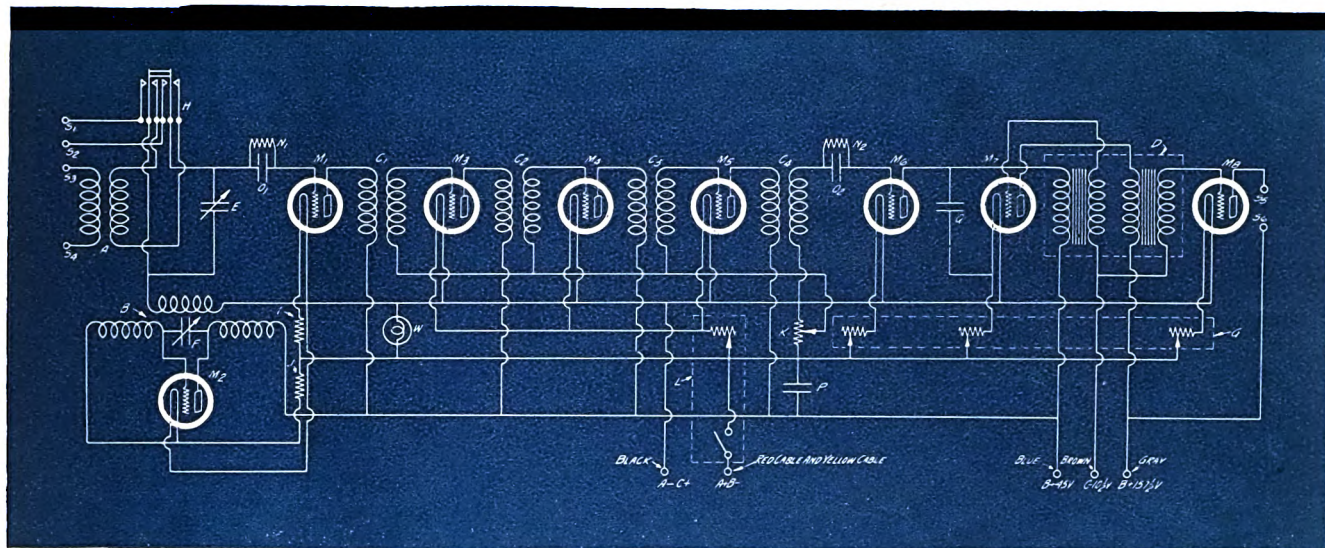
L—Yaxley rheostat switch, 6 ohms;
M1, M2, M3, M4, M5, M6, M7 and M8—Benjamin Cle-ra-tone vacuum valve sockets;
N1 and N2—Sangamo fixed condensers, .00025 mfd., equipped with grid-leak mounting;
O1 and O2—Durham metallized resistors, 2 megohms;
P—Tobe by-pass condenser, 1 mfd.;
Q—Sangamo mica fixed condenser, .0035 mfd.;
R—Yaxley cable plug;

S1, S2, S3 and S4—Yaxley pup jacks;
T—Hammarlund illuminated double-drum dial;
U—Lignole drilled and decorated wood panel, 7 by 26 inches;
V—Corbett baseboard (this is part of the equipment of the Corbett model C cabinet chest);
W—Yaxley pilot light, No. 310;
X1—Micarta antenna connection strip, 3 by $\frac{3}{8}$ by $\frac{1}{8}$ inch;
X2 and X3—Micarta condenser mounting strips, $3\frac{1}{2}$ by $1\frac{3}{4}$ by $\frac{1}{8}$ inch.



A "SUPER" CIRCUIT WITH FEW WIRES

FIGURE 2: The instruments are outlined in BLACK and the wires are indicated in RED. The wiring is quite simple for this type of circuit.



THE VICTOREEN CIRCUIT

FIGURE 3: One novel feature of the circuit is the change-over arrangement, shown in the upper left-hand corner, which permits the use of any type of antenna that the owner desires. A turn of the switch H, makes the change.

out of the baseboard, V, that is furnished with the Corbett cabinet, to allow for the drum dial. The dimensions of this cut-out are shown in Figure 2. The eight sockets, M1, M2, M3, M4, M5, M6, M7 and M8, are mounted in a straight line in the positions shown in Figures 1 and 2. These sockets are turned with the arrows pointing as shown in Figure 2.

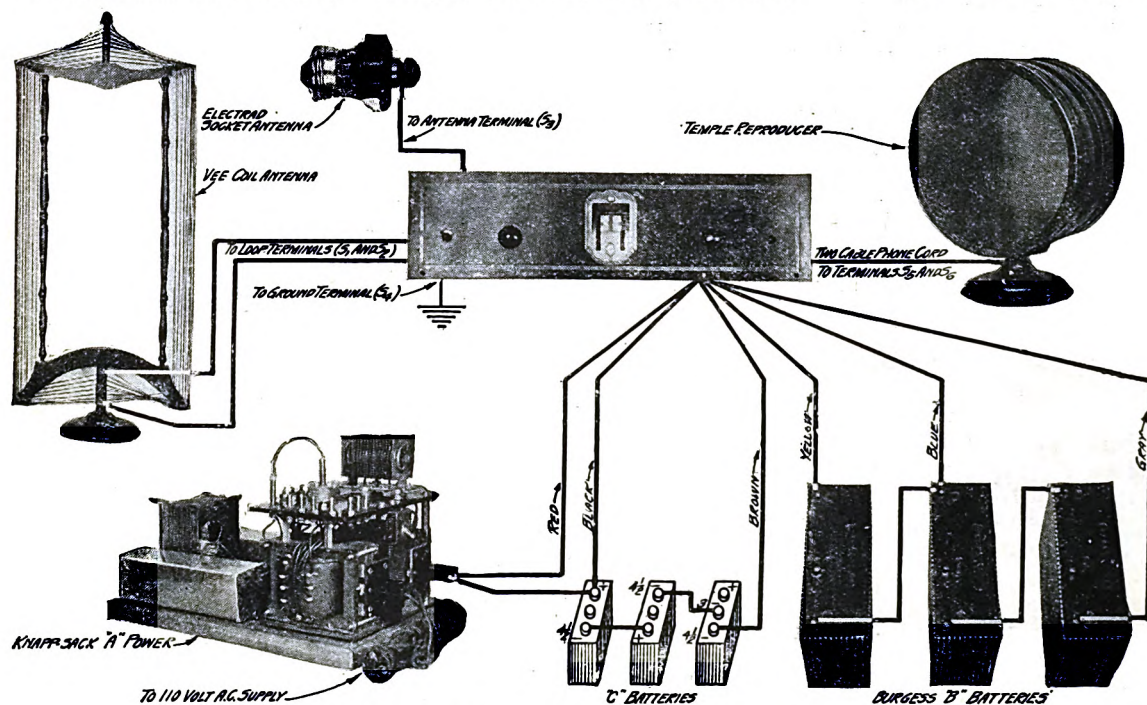
The antenna coupler, A, is mounted by means of a single screw fastened through the bracket into the baseboard,

V, in the position shown in Figure 1. The coupling unit, B, is mounted similarly in the position shown in Figure 1. The four high-frequency units, C1, C2, C3 and C4, are mounted slanting, in the positions shown in the same diagram. The audio unit, D, is drilled and tapped, as shown in Figure 2, for two screws to support the Yaxley cable plug, R. These two holes are drilled in the casing as close to the edge as possible, so that the windings are not damaged. The drill, in doing this work,

must not be allowed to go further than just through the metal casing. The unit, D, is mounted on the baseboard, V, in the position shown in Figures 1 and 2, by means of two round-head screws of suitable size for fastening down this heavy instrument.

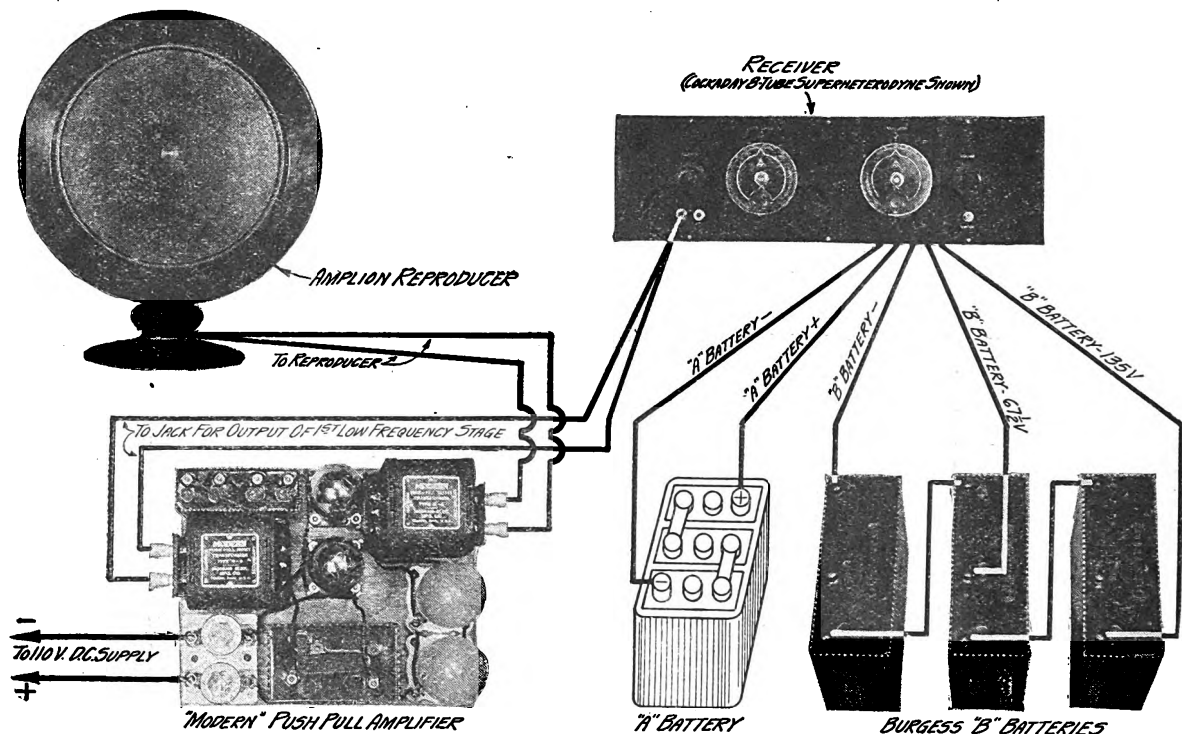
The two amperites, J and I, are fastened to the baseboard, V, with a single screw to each instrument, in the positions shown in Figures 1 and 2.

The by-pass condenser, P, is screwed
(Continued on page 78)



AN EFFICIENT OPERATING HOOK-UP

FIGURE 4: The units illustrated here have been found by tests to give very good results when hooked up with the Victoreen as indicated by the heavy black lines. Note that either a loop or socket antenna may be employed.



QUALITY AMPLIFICATION FROM THE DC LINES
 FIGURE 1: The hook-up shown above should bring cheer to those who live in neighborhoods where direct current is employed. The Modern push-pull amplifier, at the lower left, is shown supplying a 371 valve push-pull stage of low-frequency amplification for the Cockaday 8-valve superheterodyne.

THE MODERN PUSH-PULL AMPLIFIER GIVES YOU Power and Quality from DC Lines

DC house wiring may be utilized with profit by means of this powerful push-pull amplifier that employs 371-a power valves. The construction of the unit, as outlined in this article, is simple enough to complete in a very short time, and the finished amplifier should put astonishing punch into any new or old receiver.

By ALBERT G. CRAIG

THE recent development, by a number of reliable manufacturers, of input and output transformers which are suitable for push-pull amplifiers has made available a DC light socket operated amplifier capable of reproducing music with greatly improved quality.

Previously the 120 line voltage so limited the output of a power valve that ordinary room volume could not be obtained without serious distortion. However, the use of two valves in a push-pull arrangement more than doubles the undistorted output which can be obtained from a single valve using the same "B" voltage.

The present unit consists of a single stage of push-pull amplification which can be plugged in after the first low-

frequency stage of any set. The unit has been simplified as much as possible and no effort has been made to obtain "A" or "B" current supply for the remainder of the radio set. Under these conditions it was found that a filter could be dispensed with.

In contrast to many former DC light socket operated amplifiers, this unit is economical to use. It employs two CX-371-a type valves which are operated in series, and thus take only one-quarter ampere from the line. This is approximately the same as the ordinary 25-watt electric light bulb.

For the home constructor it was found desirable to use a "C" battery for a grid bias rather than to take the drop across a resistance, as the latter

method would have cut down the "B" voltage available. An extra "C" battery of $4\frac{1}{2}$ volts is connected between the input transformer and the grid of the valve, having less bias because of the series filament arrangement. These "C" batteries have to be replaced approximately once a year.

A double fuse block is used between the light socket and the amplifier to take care of any accidental short-circuits in the amplifier.

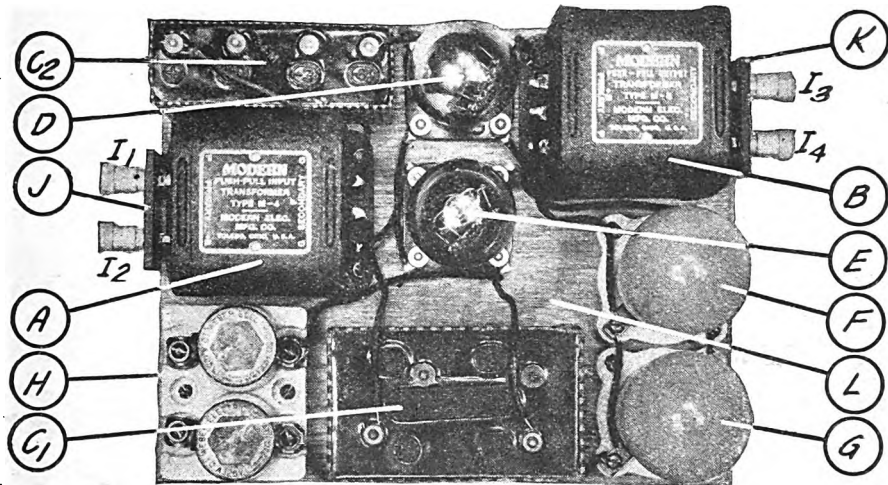
The schematic diagram in Figure 5 shows the amplifier circuit at a glance.

How to Construct the Amplifier

Cut the wooden baseboard to a size 10 inches by 8 inches by $\frac{1}{2}$ inch. Next
 (Continued on page 74)

POPULAR RADIO WORK SHEET

THE MODERN PUSH-PULL AMPLIFIER



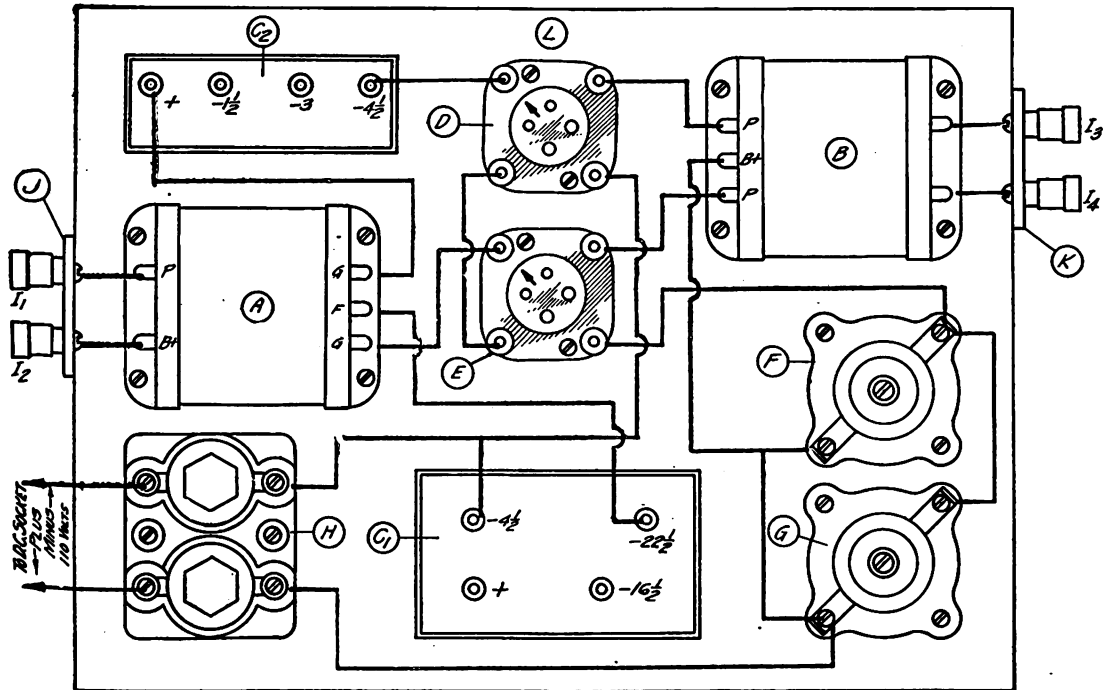
THE PANEL LAYOUT OF THE UNIT

FIGURE 2: Note the two "C" batteries that are incorporated in the panel layout of the amplifier. Ward Leonard resistances of the proper values may be used instead of the two Mazda lights in this picture.

LIST OF PARTS FOR BUILDING THIS UNIT

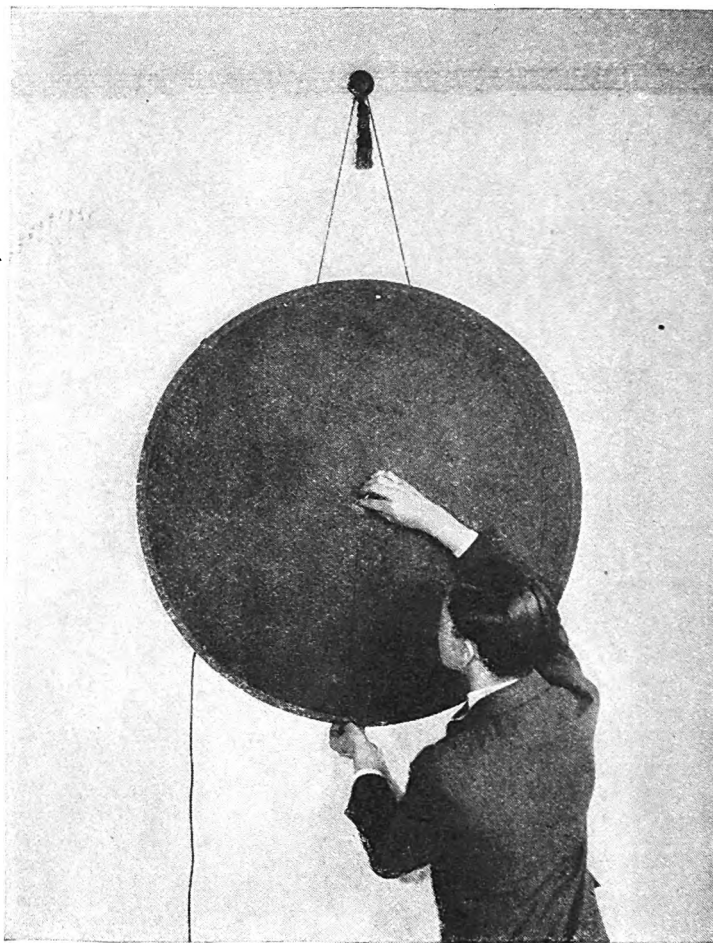
COST OF PARTS—Not over \$27.00

- | | |
|--|--|
| A—Modern Push-Pull input transformer, type M-4; | F and G—Benjamin receptacles, No. 9401; |
| B—Modern Push-Pull output transformer, type M-5; | H—Fuse block; |
| C1—Burgess "C" battery, No. 5156; | I1, I2, I3 and I4—X-L binding posts; |
| C2—Burgess "C" battery, No. 2370; | J and K—Binding-post strips, 2 by 1½ by 3/16 inch; |
| D and E—Benjamin Cle-ra-tone sockets; | L—Hardwood baseboard, 10 by 8 by ½ inch. |



HOW THE UNIT IS WIRED

FIGURE 3: All the wiring is done above the baseboard, and is indicated here in RED lines. The instruments are outlined in BLACK. The wiring job may be completed in a very short time.



AFTER AN HOUR'S WORK

The completed cone is quite distinctive in appearance when hung on the wall by means of the cord. And its tone quality, if the cone is assembled with reasonable care, should be equal to that of the best manufactured reproducers of this type.

AN HOUR'S WORK WILL BUILD THIS

3-Foot Double Cone Speaker

Here is a chance for those who admire the excellent tone and pleasing appearance of the 3-foot double cone speaker to build one for themselves—with but a small outlay in time and a still smaller outlay in money.

By THE TECHNICAL STAFF

A THREE-FOOT cone speaker with exceptional fidelity of tone may now be assembled by any novice in less than an hour's time and at a saving in cost which is very substantial and which will appeal very strongly to those with three-foot cone tastes and one-foot cone pocketbooks.

The materials for this cone are available in kit form and they may be purchased in retail stores or by direct mail.

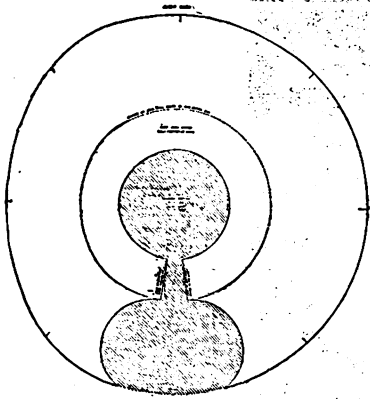
Recognizing the deserved popularity

of this particular cone, and believing that many of POPULAR RADIO's readers would be interested in learning the details of its assembly, the Laboratory Staff has assembled one, and, as a result of this work, prepared the following outline of the steps necessary in its construction.

Since the special paper (in this case called FONOTEX) is rolled in the kit to save space and the possibility of damage, it is necessary for the prospective

user to flatten the two large sheets out before any attempt is made to use them. This may be done by re-rolling the sheets in the reverse direction to that in which they were originally rolled. Care must be taken to see that no cracks or dents are permitted to develop during this re-rolling.

This is a double cone with a back and front piece. First, take the sheet marked "back cone" and with a sharp pair of scissors cut it along the solid



THE CUT-OUT OF THE BACK CONE
 FIGURE 1: The shaded portion is the part cut out. The back ring is cemented to the back cone inside the inner circular dotted line shown above.

printed lines. The sheet when finished will have the appearance of Figure 1.

The sheet of paper containing the printed outline of the front cone is now laid flat with the decorated side down. Using a sharp knife or scissors, the segment or wedge-like piece is cut out, as illustrated in Figure 2. Operations on the front cone should be suspended for the moment.

For the best results it is now suggested that the constructor place a newspaper or sheet of smooth wrapping paper under the wedge-like opening or segment, and between the two cones—that is, between the front and back cone.

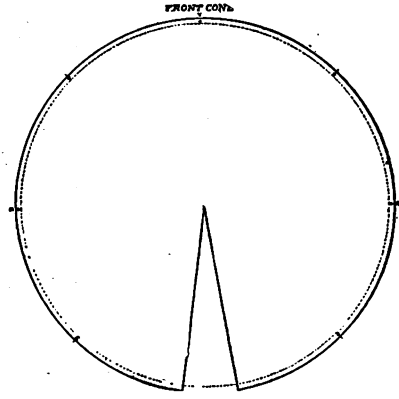
Place the cut-out back cone on the front cone, with the smooth side of the back cone against the smooth side of the front cone and along the circular dotted line of the latter.

At this point the worker should look for three arrowheads printed on each of the cones. These are plainly marked X, Y and Z. The arrowheads on the back cone should exactly meet those on the front cone, and the back cone should fit exactly into the circle made by the dotted line.

This done, the back cone should be held firmly in position by placing weights on it, which may be heavy books or flat boards loaded with flat-irons or other heavy objects.

It is now time to apply the Ambroid cement which is used as a binder. This should be started by cementing the back cone to the front cone at one tip end of the back cone. With the forefinger of the left hand hold the back cone tightly against the front cone, to prevent the cement from seeping in between the two. The worker should smoothly place a thin stream of cement directly around the circumference of the back cone. Accuracy should not be sacrificed for speed and impatience. This is a critical part of the operation and is easy enough if it is done slowly. The cement should be given a chance to set before the fingers are removed.

When the worker has gone completely around the back cone, a second trip is made. This time the spout of the ce-

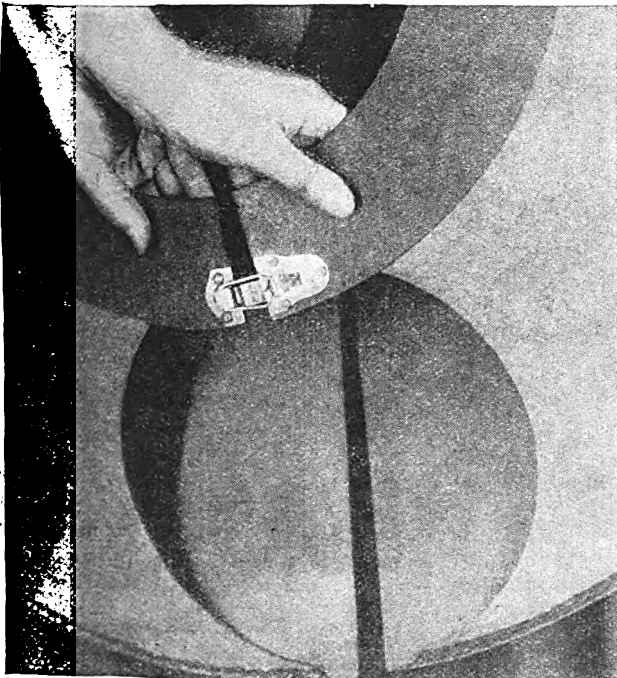


THE CUT-OUT OF THE FRONT CONE
 FIGURE 2: The wedge-shaped segment at the bottom of the diagram is cut out before the cementing process. The rest of the cutting is done after the cementing.

ment can is placed about $\frac{1}{8}$ inch in from the edge of the back cone. Care should be taken to see that the cement flows over the edge of the back cone to the front cone, so as to join the two solidly in a general line. Here again the worker must not be impatient, but should give the cement plenty of time to dry.

When the cement is thoroughly dried, the remainder of the front cone may be carefully cut away along the solid printed line. In one corner of the sheet the builder will find a diagram marked "Reinforcing Cone." This is a small cone of paper which is used to rein-

(Continued on page 90)

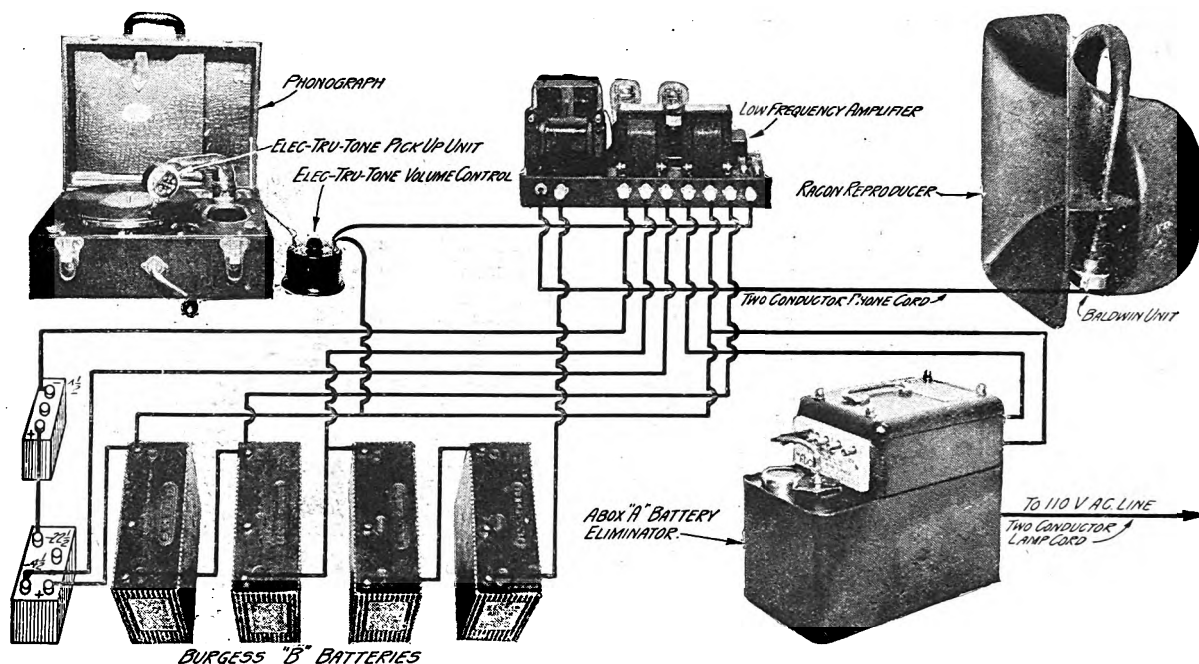


Penn Sales Corporation

Penn Sales Corporation

HOW THE CONE IS BROUGHT INTO SHAPE

FIGURE 3: At the left the cone is being brought into its final shape by fastening the back ring latch. At the right the butt joint made by the two edges of the front cone, when the cone is brought into shape, is being taped together inside the cone by means of narrow strips of adhesive fabric. The long strip is then taped over the inside joint.



A COMPLETE PHONOGRAPH COMBINATION

FIGURE 1: In this diagram the Rawland low-frequency amplifier, whose construction is described in the article below, is shown hooked up with a number of units into a combination that gives excellent results in reproduction from phonograph records.

TWO EASY NEW WAYS TO “Radioize” Your Phonograph

Two more hook-ups are here described in POPULAR RADIO'S series on the use of electrical pick-up units for revivifying phonograph reproduction. They offer the builder the choice of battery or power operation, and very fine results in tone and volume may be obtained with either of these hook-ups.

By MORRIS M. SILVER

IN the last six months POPULAR RADIO has originated and explained a number of methods for bringing the old-fashioned phonograph up to date from a reproduction standpoint. These articles have described specific combinations of the new and increasingly popular electrical pick-up unit with various types of amplifiers and radio loudspeakers. This information has been complete and in such simple language that anyone can make the change and get reproduction that is natural and for that reason very enjoyable.

Regardless of how old a phonograph is or how bad it sounds at present, one of the new units added to it will so transform its reproduction that it will be immediately placed upon the same plane as the most expensive radio receiver now obtainable.

In this article two improved combinations of this sort will be described.

The first one consists of a two-stage, transformer-coupled amplifier in combination with an exponential horn-type reproducer. With these units hooked up, as shown in Figure 1, any phonograph can be rejuvenated.

How the Low-Frequency Amplifier Is Constructed

In the amplification unit, which was designed and built in the POPULAR RADIO Laboratory, the instruments are mounted upon a ½-inch thick wooden baseboard cut to the size of 12 inches by 6 inches. A binding-post strip is cut from ¼-inch formica to the size of 12 inches by 1½ inches. This is drilled for mounting the eight binding posts, L1, L2, L3, L4, L5, L6, L7 and L8, and the jack, G. When these parts are screwed down, as shown in Figure 2, the binding-post strip, J, is screwed into one of the long sides of the base-

board, K, as shown in Figure 2. Then the other pieces of apparatus, including the filament controls, H and I, the two transformers, A and B, the choke coil, E, and the filter choke, C, the two sockets, D1 and D2, and the paper condenser, F, are also fastened to the baseboard.

The instruments, when mounted, are wired up according to the picture wiring diagram shown in Figure 3.

In this diagram the parts and instruments are outlined in black lines and the wiring is shown in blue. If the wiring is followed exactly, the results outlined in this article will be obtained.

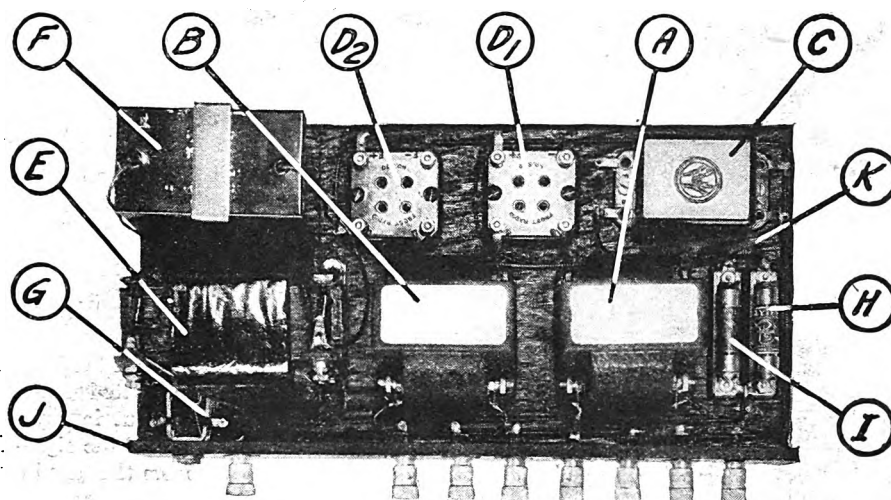
How the Combination Is Used

In Figure 1 is shown a pictorial hook-up for a phonograph with a new electrical pick-up attached to it, as well as a special volume control. The low-

(Continued on page 92)

POPULAR RADIO WORK SHEET

THE RAULAND PHONOGRAPH AMPLIFIER



A TOP VIEW OF THE AMPLIFIER

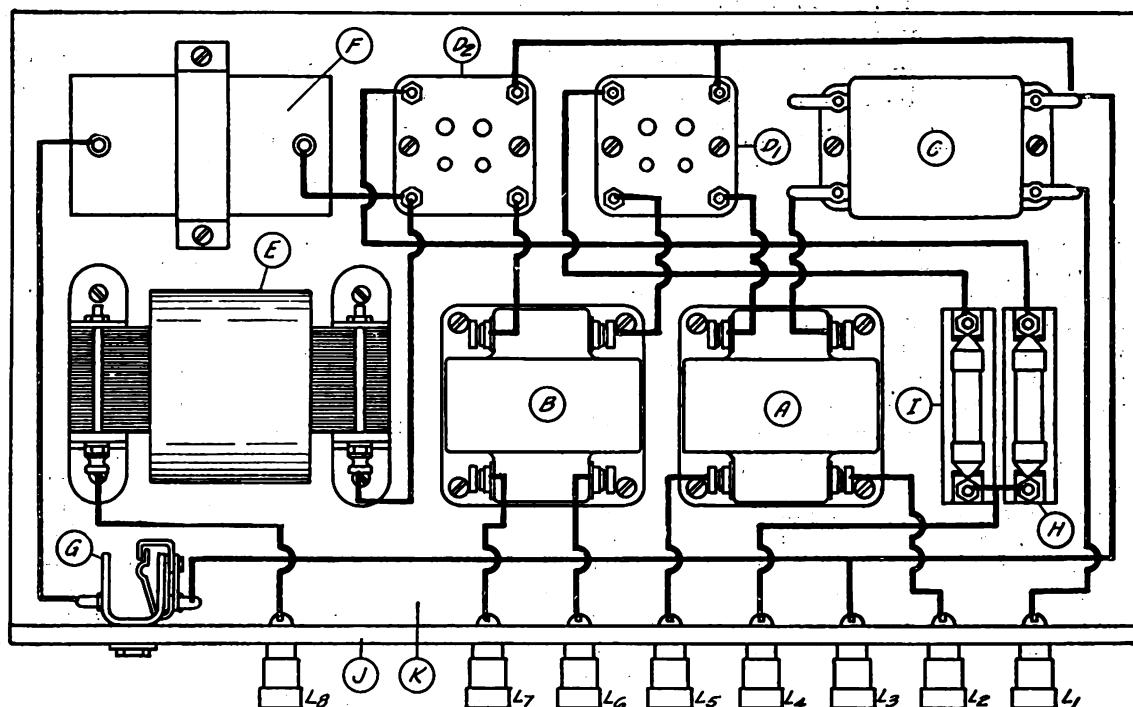
FIGURE 2: Here is shown the layout of the parts mounted on the wooden baseboard and the arrangement of the binding-post strip, J, and the jack, G.

LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$39.00

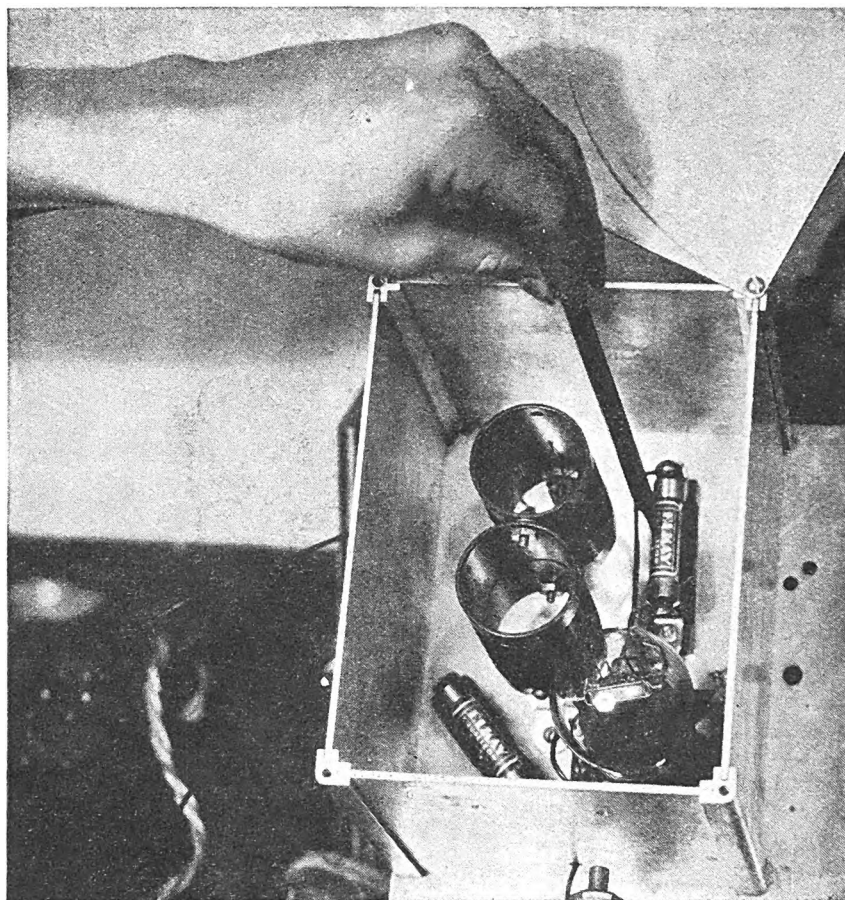
A and B—Rauland Lyric All American low-frequency transformers, type R-500;
 C—High-frequency Laboratories R. F. choke, L-425;
 D1 and D2—Frost bakelite sockets, No. 530;
 E—AmerTran choke, No. 854;
 F—Polymet filter condenser, 4 mfd., 600 volts DC;
 G—Frost Gem Jac, open-circuit, No. 953;

H—Polymet Polytrol No. 1, with mounting;
 I—Polymet Polytrol No. 5, with mounting;
 J—Binding-post strip, 12 inches by 1½ inch by 3/16 inch;
 K—Hardwood baseboard, 12 inches by 6 inches by ½ inch;
 L1, L2, L3, L4, L5, L6, L7 and L8—X-L binding posts.



THE PICTURE WIRING DIAGRAM

FIGURE 3: This diagram outlines all of the instruments and parts in black; the wiring is shown in heavy blue lines that indicate exactly where the wires are to be run and connected.



HOW GRID SUPPRESSORS ARE USED

This picture shows one of the shielded stages of the LC-28 high-frequency amplifier, with the grid suppressor connected in the circuit between the tuning circuit and the grid of the valve.

MAKING BALKY SETS BEHAVE WITH SUPPRESSORS

By ERNEST ROULTON

THERE were many thousands of sets built during the early days of radio in which high-frequency amplifiers were cascaded together in one, two, or three stages, that were not inherently stabilized.

An unstable condition in such an amplifier is bound to produce squeals and howls that interfere not only with the operator's reception, but with reception in nearby receivers that are tuned to the same wavelength.

One old method for controlling oscillation was by means of a rheostat in the filament circuit. This was used as a combination volume control and oscillation control. Another method was to use a potentiometer for varying the grid bias. Still other methods used absorption circuits for preventing oscillation.

All of these, however, controlled regeneration by some form of loss, so

that the total amplification was reduced and the circuit's criticalness was affected. This, of course, reduced the over-all amplification and likewise necessitated an adjustment for various wavelengths.

Another method that has been described somewhat at length in the September, 1927, issue of POPULAR RADIO, in the article on the design of the LC-28 receiver, makes use of grid resistances, commonly known as suppressors. This use of a grid suppressor in high-frequency circuits presupposes a grid resistance unit in which the distributed capacity across the resistance winding is exceptionally low and also a resistance unit that is practically non-inductive. Resistances such as the Elkey suppressor or the Lynch suppressor are made with a double winding, wound so that one-half of the natural inductance counteracts the other

half of the natural inductance of the unit.

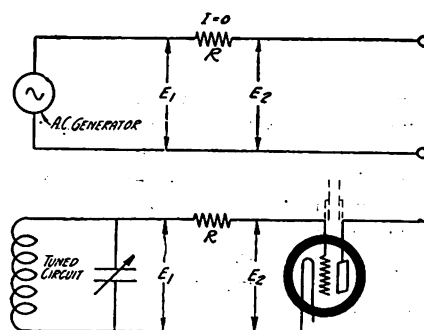
In Figure 1 are shown two diagrams. In the top diagram is an alternating current generator with a resistance connected in the upper leg of the circuit.

If the circuit is left open, the current flowing through the resistance, R , will be zero, and in this case the voltage drop across the resistance, R , will be zero, when no load is applied across the output.

In the bottom diagram is shown the same principle applied to a vacuum valve, high-frequency amplifier circuit. If the resistance, R , is of the proper size, feedback due to current flowing through the imaginary condenser, shown in dotted lines, would be eliminated without in any way affecting the voltage of the signal impressed on the grid from the tuned circuit. In other words, the voltage E_2 will equal the voltage E_1 . The "C" battery applied to the stage should be correct for the plate voltage applied to the plate circuit of the vacuum valve to produce the best results.

These types of suppressors are available in sizes ranging from 100 to 2,000 ohms in steps of 100 ohms. For installing suppressors in ordinary one-, two- or three-stage high-frequency receivers, the wire running from one side of the tuning condenser to the grid of the vacuum valve should be cut, and a grid suppressor and mounting should be placed in position and wired into the circuit. For standard types of receivers a value somewhere between 500 and 700 ohms should be approximately correct. Higher values of grid suppressors will tend to further suppress squealing and lower values will increase regeneration.

The proper use of suppressors in the grid circuits will improve any receiver and will eliminate howls. Suppressors are not used in detector circuits—only in the high-frequency stages.



HOW THE SUPPRESSOR PREVENTS CURRENT FLOW

FIGURE 1: This diagram shows the analogy between an AC generator circuit, with the resistance, R (top diagram), and the grid circuit of a high-frequency stage of amplification (bottom diagram).



AN AUTHORITY ON RADIO AT THE AGE OF TWENTY

Baron Manfred von Ardenne, author of this article, is here shown holding one of the "multiplex" valves of his own design. (See his article in POPULAR RADIO for September, 1927.) He is known on both sides of the Atlantic as an authority on the subject of low-frequency amplification.

A SIMPLE NEW METHOD FOR

Measuring Grid Current

This article, which should interest every experimenter who is anxious to get the utmost efficiency out of radio apparatus, tells how delicate grid measurements on vacuum valves may be made with instruments many times less sensitive than those usually employed.

By MANFRED VON ARDENNE

TO get good reproduction in a low-frequency amplifier, it is of great importance that the grid current flowing be accurately determined.

If a considerable amount of grid current flows in the circuit, then distortion is induced, and this, in the case of low-frequency amplifiers, makes satisfactory reproduction impossible.

The instruments that are necessary for directly measuring grid currents have to be sensitive—down to about a hundredth of a microampere. In special cases it is even desirable to measure grid currents of the order of ten-thousandths of a microampere.

This new method of measuring grid currents, devised by the writer, enables

these currents to be measured indirectly by means of an instrument that is included in the plate circuit of the vacuum valve; the necessary sensitivity of this instrument may be ten thousand times less than that otherwise necessary in direct grid-current measurements.

Thus a simple milliammeter in the plate circuit is made to measure grid currents of the order of tenths of a microampere.

This method has been evolved from a consideration of the fact that if grid current is flowing, then a potential drop will be induced across a resistance included in the grid circuit. This potential drop changes the effective grid

potential and, in turn, the value of plate current.

If the degree in which the plate current changes with the grid potential is known (and that is always the case if the characteristic of the valve in question is given), then it is possible to calculate the change of grid potential from the measured variation of plate current.

The change of grid potential in volts is equal to $I_g \times R_g$, where I_g is the grid current in amperes and R_g is the grid resistance included in the circuit, in ohms.

Thus it is only necessary to divide the calculated change of grid potential by the grid resistance in order to know

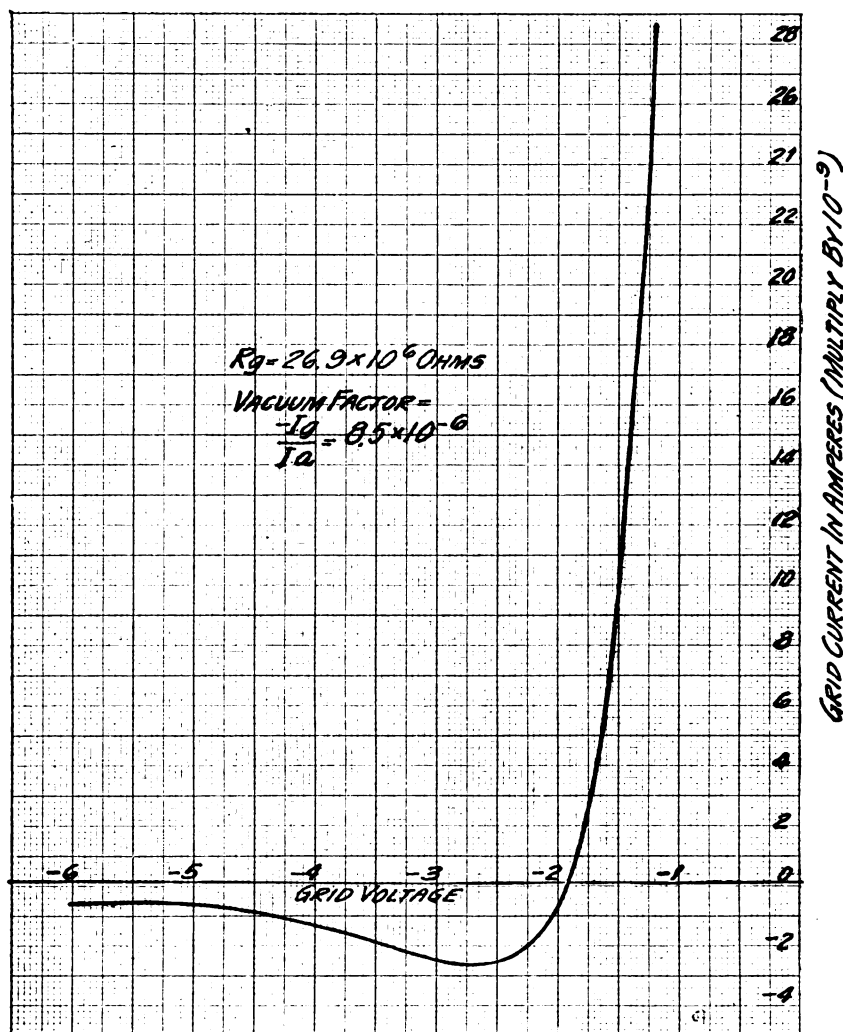


FIGURE 1: A grid-voltage, grid-current curve that shows the variation of these two factors in a vacuum valve.

the amount of grid current flowing in the circuit.

The formula for the grid current in this measuring arrangement is

$$I_g = \frac{\Delta E_g}{R_g}$$

where I_g is the grid current and R_g is the grid resistance and ΔE_g is the change of effective grid potential calculated from the variation of plate current measured.

The sensitivity of this method is proportional both to the steepness of the valve characteristic and the amount of resistance included in the grid current. For the usual characteristic steepness of about

$$5.0 \times 10^{-4} \frac{\text{ampere}}{\text{volts}}$$

and a grid resistance of about 20 megohms, the sensitivity is equal to $S \times R_g = 10000$. This sensitivity enables grid currents of $1/10000$ of a microampere to be measured by means of a simple millimeter in the plate circuit.

In Figure 4, the measuring layout is given.

R_g is the grid resistance
 S is the short-circuiting plug
 P is the grid-bias potentiometer
 C is the grid bias battery
 R_h is the filament resistance
 A is the filament battery
 V_1 is the valve filament voltmeter
 V_2 is the grid potential voltmeter
 V_3 is the plate potential voltmeter
 B is the plate potential battery
 MA is the millimeter in the plate circuit.

The valve characteristics are taken by means of changing the grid potential
 (Continued on page 70)

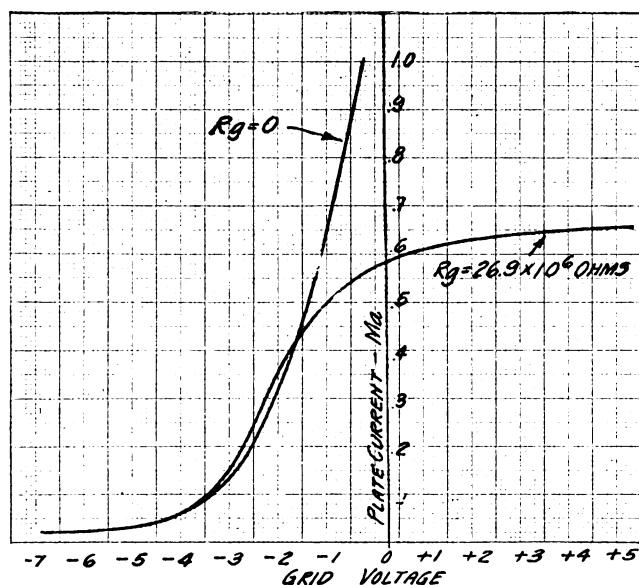


FIGURE 2: A grid-voltage, plate-current characteristic of a vacuum valve, showing how this factor varies with different conditions of grid resistance.

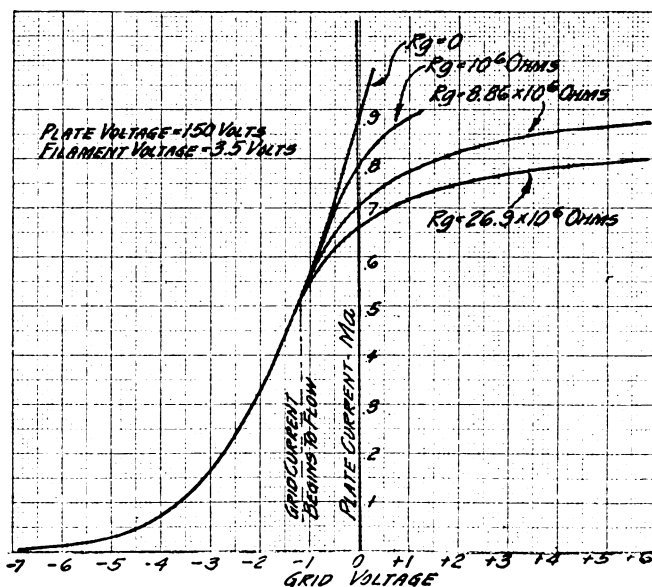
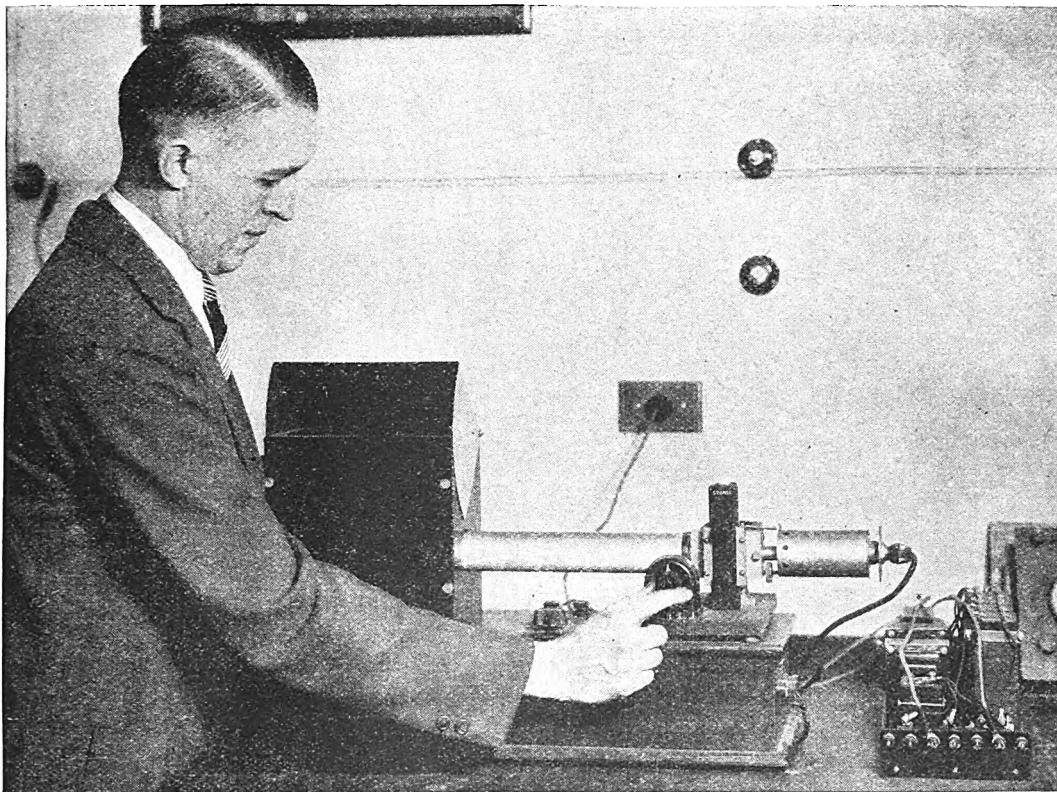


FIGURE 3: A family of grid-voltage, plate-current curves, taken with varying conditions of grid resistance values, indicating the point where grid-current begins to flow.



MAKING A HUM SHOW ITS PATH

By means of the oscillograph, shown in the picture above, oscillating currents are made to trace, on a screen, luminous paths showing their wave form. The engineer is shown testing the output of a power-pack with this delicate instrument in the POPULAR RADIO Laboratory.

Trailing the Elusive Hum

Have you had trouble with annoying hums in your power-operated set? Do your "A" power apparatus, your "B" power packs or your AC valves refuse to give silent, satisfying operation? It is probable that you have neglected some of the precautions that must be observed when using the AC lighting lines as a power source. This article gives valuable information on tracing down these annoying hums that sometimes occur when power operation is used incorrectly.

By CHARLES L. DAVIS

A SUCCESSFUL power-pack, and in fact any current-operated receiver, should work without annoying extraneous noises of any kind being generated within them. This, of course, is an ideal condition much sought after by the broadcast listener.

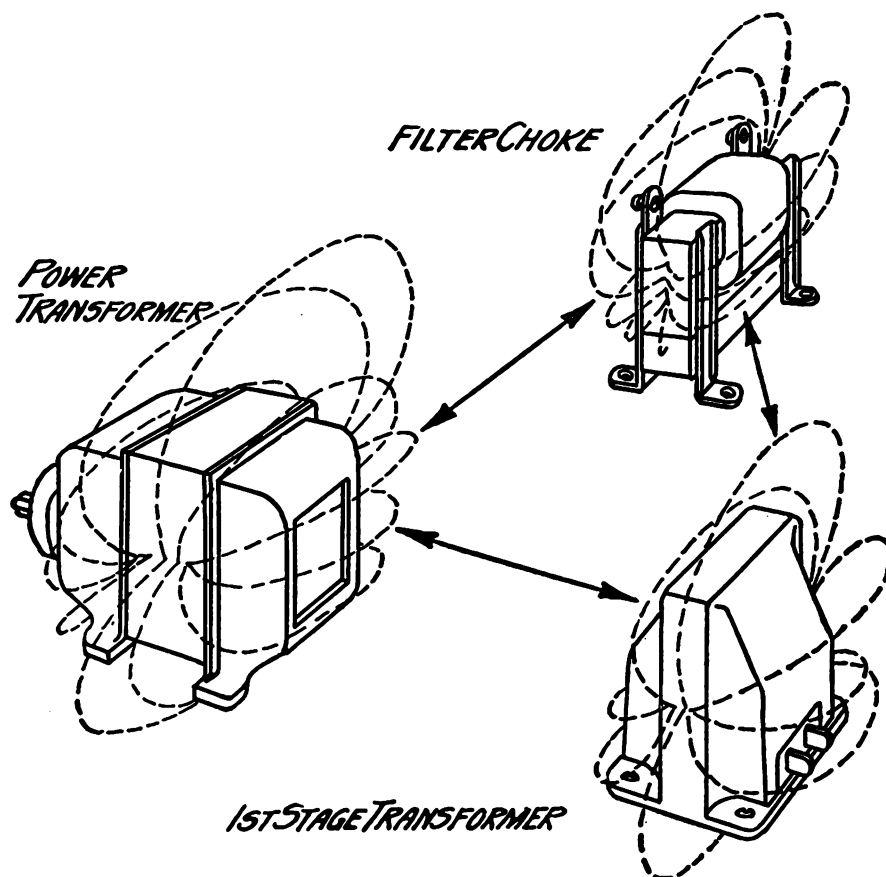
Absolutely silent operation, however, is seldom obtained, although in cases of well-designed power units or receivers the hum is usually reduced to a value where it causes no great disturbance and soon becomes practically unnoticeable to the regular listener.

However, many experimenters have built power-packs or have used various types of AC valves without being able to find out the cause of this form of trouble.

This is particularly true now, since the low-frequency amplifying apparatus used in modern receiver designs has been brought up to its present high standards. The better amplifying apparatus to-day amplifies and reproduces the low notes of the musical scale to a higher degree than ever before, and if there is any trace of hum generated

in the power apparatus it may immediately become evident as a very bothersome noise, because its fundamental frequency is at the low range of the musical scale. The frequency of the hum that may cause trouble is of the same frequency as the alternating current in the lighting circuits—60 cycles. Other frequencies that may be generated as harmonics—120 cycles, 240 cycles, etc.—may cause minor trouble, although usually not so annoying.

A brief consideration of the causes of hum in power apparatus, therefore,



ISOLATING THE FIELDS OF TRANSFORMERS AND CHOKES

FIGURE 1: Interaction between the magnetic fields of transformers and choke coils is one of the most common sources of hums. In their efforts to get a simple and compact layout, many set builders crowd their instruments, with disastrous results. The spacing shown in this diagram is an example of good spacing of instruments. Notice that the fields, shown in dotted lines, do not interlink, but are separated by distances indicated by the arrows.

should be of great interest to set builders.

Of course, the idea back of noiseless operation from an alternating current source of power presupposes a method of rectification or changing of the alternating current into a unidirectional current of certain prescribed voltages. This is accomplished by a step-up transformer and rectifier valve. Direct current in this form, however, is not suitable for reception purposes because it will be pulsating in nature, whereas it should be a pure direct current without variations in strength or amplitude.

The type of unit required to eliminate these harmful pulsations that are left after rectification is known as a filter circuit, of which a standard one is shown at A in Figure 3. This standard filter consists of two choke coils in series, that have a smoothing effect upon current ripples, and three condensers, that have a storage effect on the direct-current impulses supplied to them. Theoretically, such a circuit should take out all pulsations and give silent operation.

However, when a heavy load is taken from such a circuit the inductance of the choke coils may decrease rapidly and thus serve to let quite a percentage of "ripple" through to the amplifying apparatus. This is true where large power valves are used in the last stage of amplification.

Strangely enough, considerable AC ripple can be applied to the last power

valve in a set without causing a noticeable hum, although, if this same ripple should be applied to previous amplifier stages the ripple itself would be amplified along with the signal and would produce a terrific hum that would undoubtedly spoil reception.

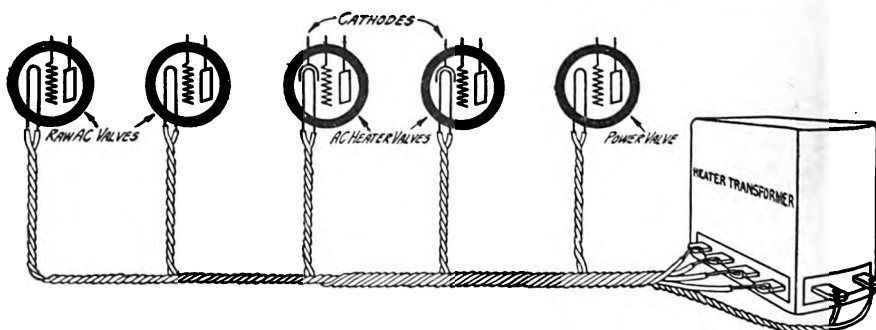
One method of eliminating this trouble is to connect the high voltage lead for feeding current to the power valve in the last stage, so that its load will come through *only one* of the choke coils. This leaves only a small load on the second choke coil and its inductance value will be maintained at a high enough value to filter out the ripple in the DC lead that feeds the other amplifier valves and the detector valve. Such a scheme is shown at B in Figure 3, and in many cases corrects a power-pack where the filter itself is at fault due to overloading.

Of course, it is presupposed that the choke coils are properly made and have an inductance large enough at the loads at which they are to be used, and also that the three filter condensers are of large enough capacity to offer little resistance to the AC ripple currents, at the same time storing up a suitable supply of direct current for the receiver's needs.

However, no change that could possibly be made in the filter can eliminate a hum that may be generated directly by induction.

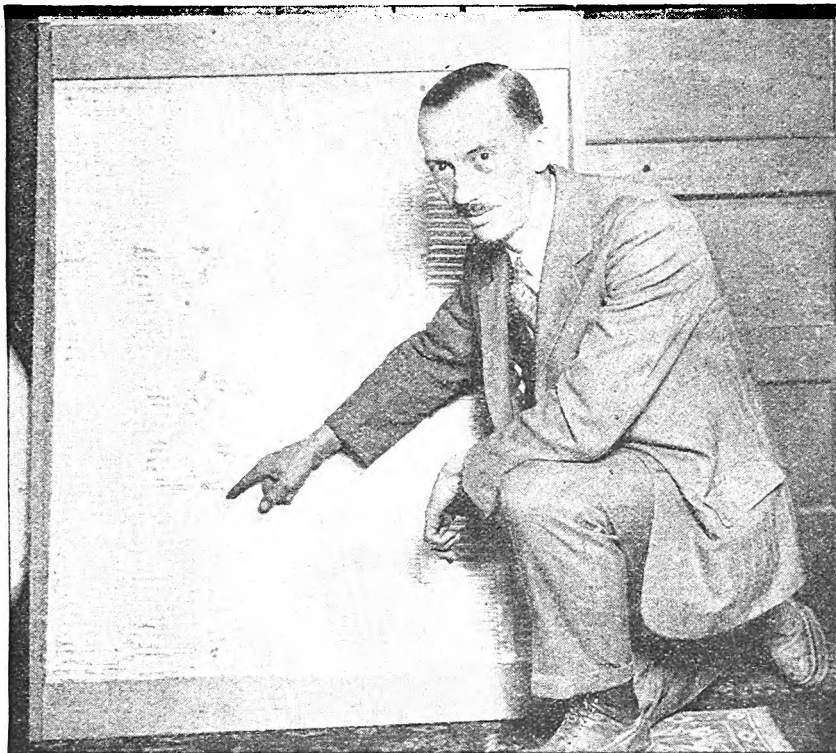
As seen in Figure 1, the power transformer used in the power-pack, as well as the filter chokes and the first-stage transformer in the low-frequency amplifier, have electromagnetic fields that spread to a considerable distance in their immediate vicinity. If these instruments are placed so close to each other that the fields interact, an alternating-current voltage will be set up in the chokes and in the low-frequency transformer that will be amplified along with the signals, producing a bad hum in the loudspeaker.

(Continued on page 68)



THE FILAMENT WIRING FOR AC VALVES

FIGURE 2: By twisting the wires of the AC leads to the filaments of AC valves, the fields of the individual leads are made to neutralize one another, so that the field is confined to the cable itself, and cannot affect other nearby circuits. This precaution should always be observed with AC valves.



A NEW IDEA IN LOUDSPEAKER CONSTRUCTION

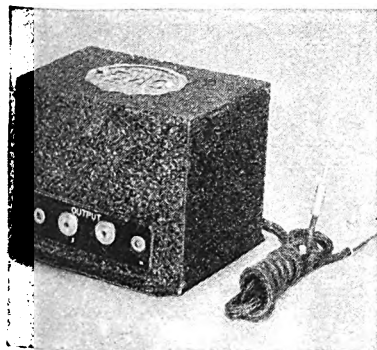
Instead of the familiar magnetic coil construction of the ordinary loudspeaker, this unique reproducer unit, the patented invention of Collin Kyle, of San José, Cal., employs electrostatic attraction and repulsion as its operating principle. The complete absence of mechanical parts prevents it from getting out of adjustment, and the large vibrating surface makes for distortionless reproduction.

What's New in Radio

Conducted by

THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.



An Output Unit for Power Valve Receivers

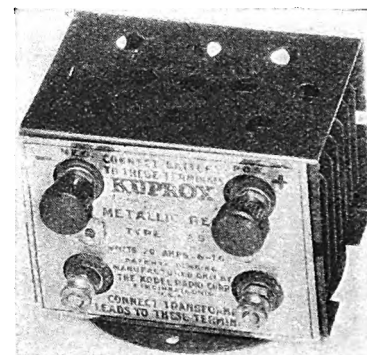
Name of instrument: F M C speaker filter.

Description: This is a neat unit, intended primarily for use outside of the re-

ceiver cabinet, although it may be mounted within the cabinet if space is available. It measures $3\frac{1}{2}$ inches by $3\frac{1}{2}$ inches by 3 inches in height over all and is inclosed in a neat metal case which is finished in crystalline black. An extension cord with phone tips projects through an insulating bushing in one side of the case. This cord is for connection to the output terminals of the receiver. On the other side of the case is a small insulating panel which carries two tip jacks to accommodate the loudspeaker terminals. The extension cord that comes with the unit permits placing the loudspeaker at some distance from the receiver.

Outstanding features: Compact in size. Neat in appearance. Provides protection for reproducer windings against the high direct current present in the output of receivers that employ power valves.

Maker: Ford Radio & Mica Corp.



An Absolutely Dry Rectifier for Trickle Chargers

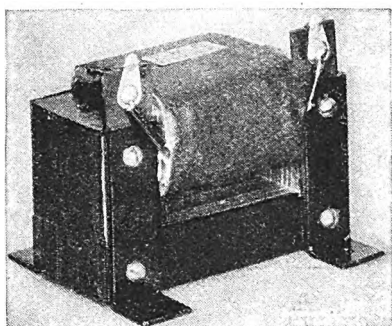
Name of instrument: Kuprox trickle charger unit.

Description: In this rectifier unit the rectifier elements are of metal. It is

therefore indestructible and requires absolutely no attention. Its life is said to be indefinite, inasmuch as the elements do not deteriorate with use. A number of these rectifier elements are clamped together and are inclosed in a perforated metal case which is open at the ends to permit free dissipation of heat. The unit illustrated may be used with a suitable transformer to make a trickle charger, or may be substituted for broken-down rectifier jars in electrolytic rectifiers. Four binding posts are provided on the unit, two for connection to the transformer output and two for connection to the battery.

Outstanding features: Absolutely dry. Requires no attention. Sturdy and indestructible.

Maker: Kodak Radio Corp.



A Most Useful and Handy Choke Unit

Name of instrument: F M C 30-henry choke.

Description: The heavy iron core used in this choke is solidly clamped and the construction throughout is rugged. Terminals are provided in the form of soldering lugs which are mounted on insulating strips at the top of the unit. An impregnated winding is used and is covered with an insulating cloth. The unit is much smaller in size than most chokes of the same electrical characteristics and is an excellent unit for use in the filters of small power-packs. It is rated at 90 milliamperes current carrying capacity and has an inductance of 30 henries.

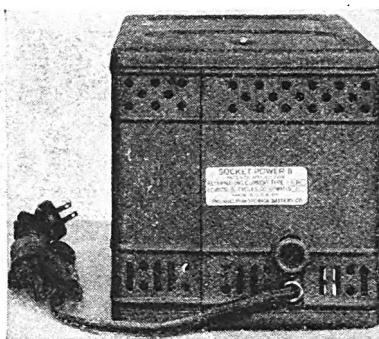
Outstanding features: Reasonable price. Small size. High current carrying capacity and inductance.

Maker: Ford Radio & Mica Corp.

A "B" Power-Pack Without Rectifier Valves

Name of instrument: Philco socket power B, types 86 and 82.

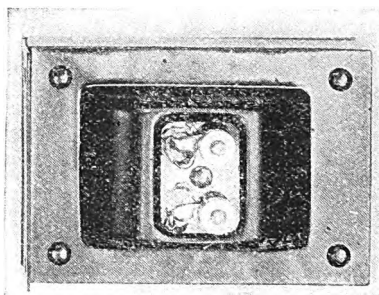
Description: The rectifier used in this Philco unit is unusual, in that it is of the electrolytic type. There are eight electrolytic rectifier cells in the unit. These do not require the addition of water, as do ordinary rectifier cells, but instead are replaced with new ones when worn out. In other respects this "B" supply unit is standard, but with a number of refinements. For instance, there is an adjustment inside to adapt it to receivers of different size. Also, it is fool-proof, in that the power is automatically turned "off" if the cover of the metal case is raised. There are



terminals to provide three "B" voltages, as required by most receivers, and the intermediate voltage is adjustable. The device will provide up to 196 volts at a current drain of 50 milliamperes.

Outstanding features: High voltage. Unusually fine rectification. Type 86 for use where supply is 50-60 cycle. Type 82 for use with 25-60 cycle supply. Fool-proof. Well ventilated.

Maker: Philadelphia Storage Battery Co.



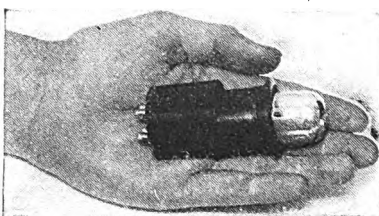
A Capable Low-Frequency Transformer

Name of instrument: Type H low-frequency transformer.

Description: This is a new addition to the well-known line of Dongan transformers. It is a carefully designed and constructed job with an unusually husky iron core, which in part accounts for the even amplification obtained throughout the band of useful tone frequencies. The windings are completely inclosed within a metal case, except for small panels of composition material on either side, which serve as mountings for the four terminals. Flanges are turned out at the bottom for mounting the transformer. The cost is unusually low for a transformer of such ability.

Outstanding features: Good amplification characteristic curve. Well constructed and neat in appearance.

Maker: Dongan Electric Mfg. Co.



A Handy Socket Adapter

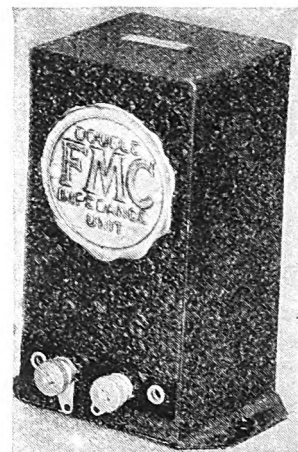
Name of instrument: UX valve adapter.

Description: The purpose of this adapter

is to permit the use of UX-199 type valves in receivers that are equipped with old-style standard sockets—something which could not be done heretofore because of the small base on the 199 valve and also because the old-style UV-type socket required the use of a bayonet pin. The new adapter consists of a threaded composition collar and a base. The collar is small enough to fit down inside of the base and screws into a thread on the inside of the base. The base is perforated at the bottom to permit the prongs of the 199 valve to project through. To assemble this adapter on a 199 valve, the collar is slipped over the upper part of the valve, then the base is slipped up over the base of the valve. When the collar and base are screwed together, the valve is held firmly between them.

Outstanding features: Makes it possible to use UX-199 valves in any receiver which is equipped with old-style UV standard sockets.

Maker: DeJur Products Co.



This Coupling Device Increases Amplification Without "Blocking"

Name of instrument: F M C double impedance unit.

Description: Two separate impedance coils and a coupling condenser are included in a metal can which is finished in a crystalline black. Thus this single unit includes all equipment for a single stage of double impedance-coupled low-frequency amplification, excepting the valve. It is equipped with four binding-post terminals, clearly marked P, B, G and F to avoid any possibility of error in connecting the units into the circuit. The advantage of this type of coupling is that the use of an impedance coil in the grid circuit, as well as the plate circuit, tends to permit greater amplification without overloading or blocking.

Outstanding features: Can be readily substituted in any low-frequency amplifier for either transformers or resistance coupling by simply removing the old units and replacing with these new ones. Occupies comparatively small base room in receiver. Different types made for different low-frequency stages.

Maker: Ford Radio & Mica Corp.



A "B" Power-Pack Without a Rectifier Valve

Name of instrument: Balkite model B-135 "B" power-pack.

Description: Where ordinary receivers, including those which employ a 112 type of valve in the last low-frequency stage, are used, this "B" power-pack provides an excellent source of high-voltage "B" power. It includes the necessary filter, transformer and electrolytic rectifier, all inclosed within a neat metal container. It operates from the 110-115-volt, alternating-current, house-lighting lines. There are two types available, one for a 60-cycle supply system, which is the most common, and the other for use in communities where the supply source is 25-40 cycle. It will supply a pure DC voltage of 135 or slightly higher. It is equipped with an extension cord and plug for connection to the light socket and has binding posts for the various voltages for the receiver supply.

Outstanding features: No larger than a single 45-volt "B" battery. All current-carrying parts entirely inclosed. Smooth in operation and economical to operate.

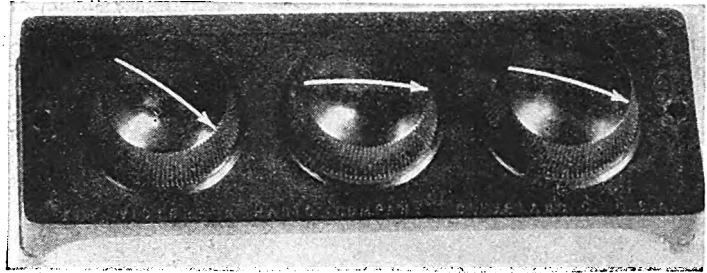
Maker: Fansteel Products Co., Inc.



An Accurate, Heavy-Duty Resistor

Name of instrument: "Hy-Watt" fixed resistor.

Description: This new resistor consists of an isolantite tube on which is baked a coating of special resistance compound. This compound is homogeneous in nature and provides a continuous and constant resistance path. The completely coated tube presents comparatively low resistance to current flow. To obtain the required resistances, a spiral groove is cut in the resistance. This groove cuts completely through the resistance coating and leaves the resistance coating in the



A Filament Control That Simplifies the Panel

Name of instrument: Victoreen filament control unit.

Description: This unit contains three rheostats mounted on a composition frame to form a single unit. Screw holes are provided in the frame to permit it to be mounted on the baseboard of a receiver. The rheostats are of 30 ohms resistance each, but may be substituted with rheostats of different resistances if desired. The unit is especially useful in superheterodyne receivers where some of the valves are

more or less critical as regards the filament voltage adjustment.

Usage: To provide manual control of filament voltages in superheterodyne receivers, and particularly in the Victoreen superheterodyne.

Outstanding features: Provides exact adjustment of filament voltages. Will regulate the voltage of three or more valves. Designed for mounting on the baseboard, thus permitting the minimum number of panel controls.

Maker: George W. Walker Co.

form of a spiral ribbon on the tube. The length of this ribbon, and therefore the resistance of the unit, depends on the length of the spiral cut.

While the resistance unit is in the machine that cuts the spiral it is also in an electrical circuit with a resistance meter. As the spiral cut is started the meter shows the increasing resistance and the cut, which is made at a predetermined pitch, can be stopped when the resistance reaches exactly the desired value. This permits a high degree of accuracy to be obtained.

To insure good contact between the metal end caps and the resistance material, the ends of the resistance coated tube are electroplated. The end caps are then clamped in position on the plated ends and the whole resistance unit is given a coating of insulating compound for protection. The metal caps are equipped with soldering lugs to permit the resistance to be connected directly in the circuit without the necessity for using any kind of mounting.

Usage: In the circuits of radio receivers, transmitters or power-packs, where the resistances are not called upon to dissipate more than 6 watts.

Outstanding features: Accurate. Heavy-duty rating of 6 watts. No mounting required. Low in price.

Maker: Electro-motive Engineering Corp.

A Horn-Type Reproducer of Unusual Appearance

Name of instrument: "True-Tone" speaker.

Description: This reproducer is of the horn type and is of heavy metal construction, but so designed that there is no metallic or harsh tone evident in the reproduction. The reproducer unit is inclosed in the base of the device and the long, tapering pedestal, as well as the belled top, serve as the horn. The whole unit stands about 40 inches high. The heavy metal construction prevents the reproducer from being tipped over easily. The finish is a warm antique bronze and the distinctive appearance of the unit makes it a pleasing addi-

tion to the furniture of the home. **Outstanding features:** Acoustically well designed. Neat appearance. Sufficiently heavy to stand on the floor without danger of tipping over easily.

Maker: Yahr-Lange, Inc.





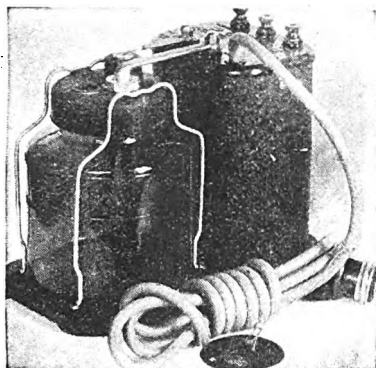
A "B" Power-Pack for Power Valve Sets

Name of instrument: Burns high-voltage "B" eliminator.

Description: This power-pack is designed for use particularly with receivers which employ a 171-type valve in the last low-frequency stage. In the case of the average large receiver, the current drain for the plate supply does not exceed 35 milliamperes; this power-pack will supply this amount of current at 180 volts. It employs a Raytheon BH type rectifier valve. All parts are completely inclosed within the metal case, including the output binding posts. Three output voltages are available, the detector and amplifier voltages being variable and the power voltage being fixed. Two variations of power voltage are obtainable, however. The unit is equipped with an extension cord and plug and with a pendant switch in the cord for turning the power "off" and "on."

Outstanding features: Provides a constant DC supply at voltages up to 180, even for receivers of unusually heavy current drain. Fool-proof and safe. Variable detector and intermediate voltages.

Maker: American Electric Co., Inc.



A Trickle Charger for Continuous Service

Name of instrument: Balkite model N trickle charger.

Description: An electrolytic rectifier is used in this trickle charger. The rectifier jar and transformer are two separate units, but are mounted on a single base. The transformer is inclosed within a crystalline-finished metal case with a composition top, upon which the necessary connection

terminals are mounted. The rectifier is inclosed within a glass jar so that the water level may be seen at all times. Two charging rates are provided. The lower one is .5 ampere per hour and is for use with receivers which consume an average of up to 7 ampere hours per day. Where the current drain on the battery is greater than this, the higher rate of .75 ampere per hour may be used. The unit is equipped with an extension cord and plug for connection to the 110-volt AC electric light socket.

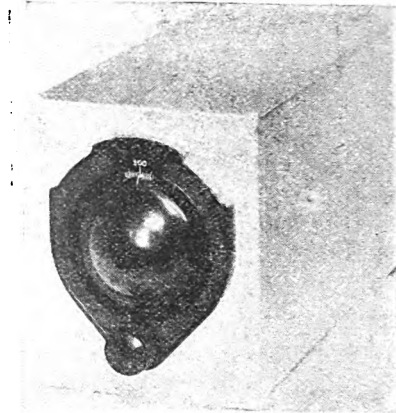
Outstanding features: Compact in size. Keeps battery constantly charged at a low cost. Water level in rectifier jar is always visible. May be obtained with a special transformer where the alternating-current supply is 25-40 cycle instead of the usual 60 cycle.

Maker: Fansteel Products Co., Inc.

A Novel and Thorough Wave Trap

Name of instrument: Wave trap.

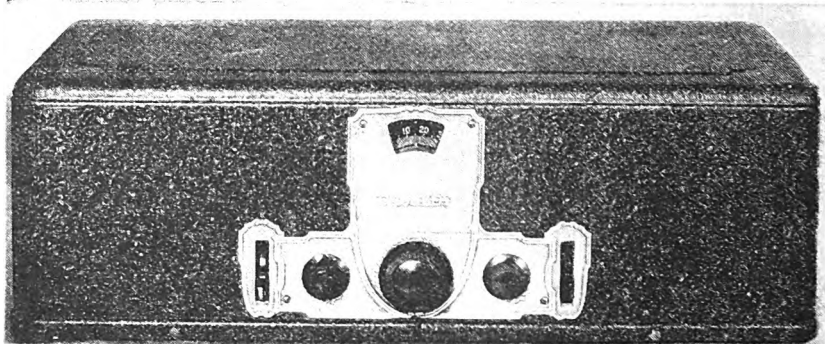
Description: This unit consists of a combination of several coils and a variable condenser, all inclosed in an aluminum box shield with a dial on the front end for operating the variable condenser. Eight binding posts are mounted on the reverse end of the shield for making connections to the receiver and the antenna-ground. By



making the proper connections, as explained in the instruction leaflet which comes with the instrument, this device will meet any trapping requirements, regardless of the number of sources of interference.

Outstanding features: This trap can be made to function as any one of the three different types of wave traps by making suitable connections to two or more of the eight binding-post terminals. Will function as a trap with either an antenna or a loop, or can be used as an antenna coupler when it is desired to use an antenna with a receiver that is designed exclusively for loop operation.

Maker: Madison-Moore Radio Corp.



An Exceptionally Fine Receiver for the Size and Price

Name of instrument: Crosley "Bandbox" receiver.

Description: It seems almost unbelievable that a receiver which measures only 17 inches in length by 7 inches in depth and 6 inches in height can employ six valves and be capable of exceptional sensitivity, selectivity and tone quality. Yet that is exactly what the Bandbox receiver is. Subjected to rigid tests of these and other qualifications, this receiver came through with unusually high honors in all of the features that go to make up the requirements for a highly desirable receiver for home use.

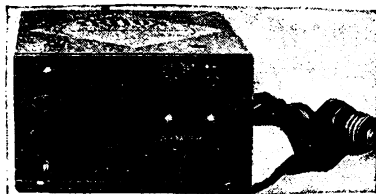
The Bandbox employs three stages of high-frequency amplification, a detector and two stages of transformer-coupled, low-frequency amplification. One of the high-frequency stages is untuned, which limits the number of tuned circuits to three; these are ganged together for control by a single knob. Not only are the individual stages shielded, but the principal components of each stage are individually shielded. This shield-

ing, together with the neutralizing methods employed, absolutely eliminates the possibility of the receiver spilling over into oscillation. As proof of this, the volume control may be turned up full and the tuning knob turned throughout the entire scale without encountering a single "birdie" whistle of oscillation.

The low-frequency amplifier employs two transformers of high quality. These too are individually inclosed within "cans" to carry out the complete shielding scheme. Suitable grid biasing is provided in order to eliminate the possibility of overloading—an important consideration in a receiver which provides such great volume of reproduction as this one.

Valves of the 201-a type are employed throughout, except in the last low-frequency stage; here the 171 type valve is recommended, although either a 112 or even a 201-a type valve may be employed with good results, particularly where "B" bat-

(Continued on page 66)



A Handy Charger-Relay Unit

Name of instrument: "Tritox" combination trickle charger and relay switch.

Description: The charger used in this unit employs the Westinghouse Rectox rectifier, which is a small rectifier that contains no liquid, requires no valves or bulbs, and operates indefinitely without attention of any kind. In addition to the rectifier, there is the usual step-down transformer and also an automatic relay switch which turns the charger and "B" power-pack (if one is used) "on" and "off" automatically with the operation of the battery switch on the receiver panel. Binding posts are mounted on the front of this unit for connections to the receiver and the "A" battery, and there is an extension cord and plug for connection to the electric light socket. A receptacle is also provided into which the plug of any "B" power-pack may be inserted, to be operated by this relay switch.

Outstanding features: Dry rectifier that requires no attention. Tapering trickle charge with decreasing charging rate as battery approaches the fully charged condition. Compact.

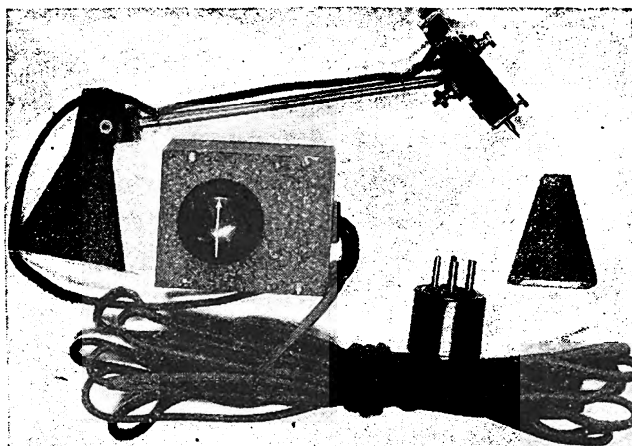
Maker: Sarvas Electric Co., Inc.



Filament Supply from the Lighting Lines for 199 Valves

Name of instrument: Type 94 "A" power supply unit.

Description: This is an "A" power-pack which supplies filament current for valves of the 199 type from the alternating current house lighting lines. It consists of a metal case which incloses the necessary transformer, a 1-ampere Tungar bulb, and two small 4-volt storage batteries and also an automatic relay switch which turns this unit and also a "B" power-pack (if one is used) "on" and "off" with the operation of the battery switch on the receiver panel. This is not a trickle charger-battery combination.



Electrical Reproduction of Phonograph Music

Name of instrument: Electrical phonograph pick-up unit.

Description: This pick-up unit is for use in reproducing the music of a phonograph record through the use of the amplifier and reproducer of a radio receiver. The tone arm of the pick-up unit is placed with its base on the phonograph next to the record, and the head of the arm, with its needle, is rested on the record in place of the regular arm. The plug at the other end of the cable is inserted in the detector socket of the radio receiver. With the receiver

turned "on" and the phonograph started, the output of the phonograph is passed on to the receiver electrically and is reproduced with the same quality as the broadcast programs picked out of the ether. The small rectangular box with the knob is the volume control.

Outstanding features: Permits even the oldest and cheapest phonographs to be used with the radio receiver to reproduce recorded music with quality equal to that obtained in broadcast reception.

Maker: Canadian Marconi Co.

The small storage cells are "floated" on the rectifier output and function as filter condensers of extremely high capacity. Current is drawn from the light line only while the receiver is in operation.

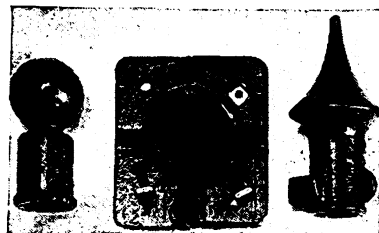
Outstanding features: Permits the filament current for receivers employing 199 type valves to be drawn from the AC light lines and thus eliminates batteries. The battery-filter is not subject to charge and discharge, and there is consequently little evaporation of the electrolyte and the unit therefore requires practically no attention. Automatic relay is built in to control both this and "B" power-pack. For the latter purpose a receptacle for the "B" power-pack plug is incorporated in the front of the "A" unit.

Maker: Sterling Mfg. Co.

is supplied from the AC mains through step-down transformers. It is a meter of the standard Weston type, with a two-inch dial.

Outstanding features: Small size. Easily mounted on a panel. Accurate.

Maker: Weston Electrical Instrument Co.



Improved Appearance for Antenna Masts

Name of instrument: W-E-B-B "Ball and Socket" aerial mast fitting.

Description: This set of mast fittings consists of a decorative tip which is provided with eyes for the halyard and guy wires, a split socket base and a ball butt for the mast. The base is attached to the roof or other mounting place by means of screws or bolts. The tip and butt are then placed on the mast pipe and the whole is mounted on the base by resting the ball butt in the base socket.

Outstanding features: This arrangement provides a firm support for the mast, but the ball and socket joint permits enough freedom of movement so that the mast may bend and give under strain without loosening the base, as would be the case if the mast were rigidly fastened to the roof. Heavy cast iron.

Maker: Timing Gears Corp.



A Meter for AC Filament Operation

Name of instrument: Alternating current voltmeter.

Description: This is a panel mounting voltmeter which measures voltages in alternating current circuits, up to a maximum of 15 volts. It is intended primarily for use in receivers or power-packs where filament current



IN THE PROFESSIONAL SET BUILDER'S SHOP

Practical pointers and kinks to increase the efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, aided by a well-equipped Laboratory, will find it and present the details to our readers in a practical and concise manner.

Resistance-Coupled Amplification at Its Best

HERE are some practical data on an amplifier that the writer has found to give excellent results in practice:

It will be noted from the accompanying diagram (Figure 1) that the conventional hook-up of the resistance-coupled amplifier has been followed, with just a few, but highly important, deviations. The resistors are of the usual .1 megohm value. It is strongly advised that the resistors be of the metallized type and of good make, to insure noiseless and lasting operation. The coupling condensers are of 0.1 mfd. capacity. The condensers should be mica insulated, to insure against leakage and breakdown. A 300-turn honeycomb coil has been found ideal as a high-frequency choke, to prevent high-frequency currents from getting into the low-frequency circuits. A standard high-frequency choke coil may be substituted if desired.

Two small by-pass condensers of .0001 mfd. capacity complete the high-frequency filter.

The first and second amplifier valves are of the MU-20 or UX-240 or Donle high-mu type of vacuum valves. The last valve should be of the UX-171 type preferably, if sufficient "B" voltage (135 to 180 volts) is available, with the correct "C" battery. The UX-112 type may be substituted if only lower voltages are obtainable. It will be noted that an output filter, in the form of choke coil and a 4 mfd. by-pass condenser, is employed. The choke coil may be the secondary of a discarded transformer, if necessary, but its inductance should approximate 60 henries. This filter is essential for satisfactory results with the UX-171 type valve.

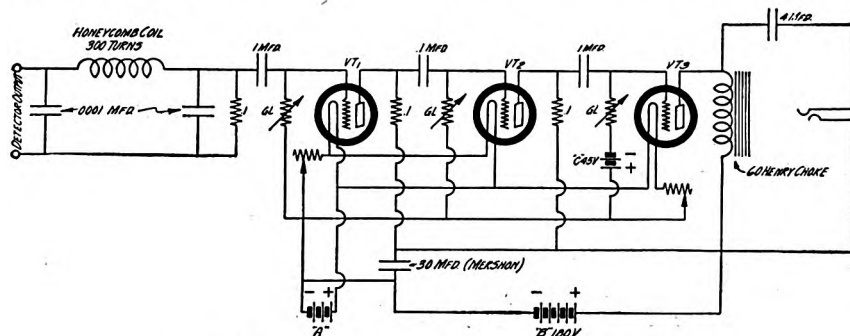
The other variations from standard practice are to be found in the variable grid-leaks, which have proved indispensable for the best results. A variable

grid-leak is virtually essential for the power valve, while the first and second valves may also be provided with grid-leaks. After experimenting with various resistance, a unit with a range of from practically zero to 5 megohms (such as the Clarostat universal resistor) was found satisfactory.

Still another and highly important variation is the Mershon condenser of 30 mfd. capacity, connected across the full plate voltage ("B" — and "B" +) of the amplifier. The purpose of this condenser is to provide the necessary reserve of energy to reproduce bass notes. It is little appreciated that the bass notes—those wonderful double bass and 'cello strains of the orchestra, and the big pipes of the organ, for example—require many times as much power as the notes of the middle register. Often, when operating resistance-coupled amplifiers on a "B" power-pack, the low notes will "crack" or fail. The cause is to be found in insufficient "B" energy. The usual condensers across the output of the "B" power-pack, serving as electrical flywheels, so to speak, are drained of their accumulated power and have not time to fill up again; hence the low bass notes are sometimes not reproduced. The Mershon condenser is an electrolytic affair, now available for various purposes. If preferred, paper condensers may be employed, having a capacity of at least 12 mfd.

With a reliable variable grid-leak such as a Clarostat, the grids of the amplifying valves may be adjusted to the precise point of top efficiency, in accordance with the other factors in the

(Continued on page 62)



A HOOK-UP FOR QUALITY AMPLIFICATION

FIGURE 1: In this schematic wiring diagram of the resistance-coupled amplifier, the high-frequency filter can be seen at the left. At the right is the output filter to keep the direct current from the windings of the reproducer. Note also the three variable grid-leaks.

The "Hi-Q" Power Supply

(Continued from page 14)

tween the black and brown terminals of the Yaxley plug, Q. The amperite, P3, should be removed and a twisted pair of filament leads should be attached to socket N6.

When this has been done, the unit is ready to be installed in the console that houses the Hi-Q "Six" receiver.

Operating the Unit with the Hi-Q "Six"

First the receiver should be set in the compartment of the Superior console, as shown in the illustration at the beginning of this article, and then the Hi-Q power-pack should be set in the upper compartment with the Balkite "A" current unit alongside of it.

Then the instruments should be connected up with the Yaxley cable, as shown in Figure 1.

Five SX-401-a valves should be inserted in the first five sockets of the receiver, and an SX-471 should be placed in the last socket.

A 4½-volt "C" battery should be installed between the ground lead and the green wire of the Yaxley cable.

The light-socket antenna should be connected to the regular antenna terminal on the set, or a regular outdoor antenna may be used if desired. The AC input wires to the Hi-Q power-pack should be connected in parallel with the two AC input wires to the Balkite "A" current unit, and the common ends of these should be connected to a lighting plug, to screw into a light socket.

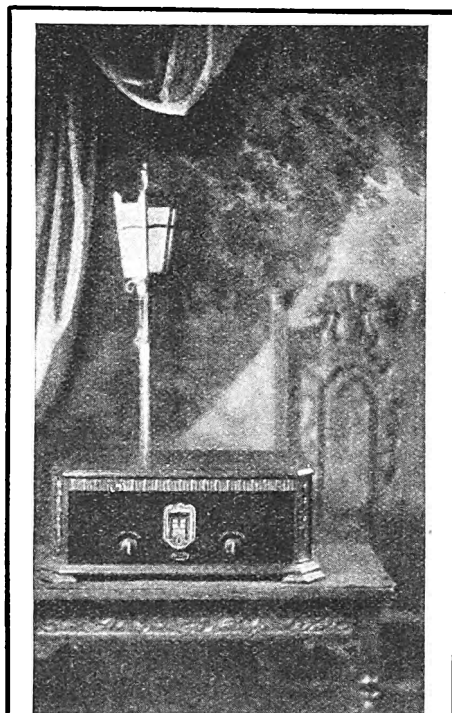
An output unit is recommended for use with the reproducer, and a decorative chest containing such a unit is shown in the diagram in Figure 1 with the proper connections to the cone reproducer. This unit protects the reproducer from high voltage currents and helps to improve the quality of reproduction. The Farrand oval cone is shown and is officially recommended with the Hi-Q "Six."

The set will tune exactly as before, as explained in the article in the December, 1927, issue of this magazine, and the proper "C" bias for the last valve in the set may be adjusted by rotating the left-hand knob on the Hi-Q power supply. The right-hand knob controls the detector and high-frequency amplifier "B" voltage and should be adjusted for the loudest signal strength obtainable with stable operation.

This combination of apparatus will give the best results obtainable with standard vacuum valves, and the complete unit will furnish excellent reproduction from both local and distant stations. The only unit that will need replacing is the small "C" battery, which should last for about a year.

The Balkite unit will need replenishing with distilled water only two or three times a season. Its operation is automatic and requires no adjustments.

The Celestial Stradivarius The Advanced Hi-Q* Six BOTH CUSTOM-BUILT!



The Hi-Q SIX—the newest advance in radio—four completely isolated tuned stages—Automatic Variable Coupling—symphonic amplification. This non-oscillating, super-sensitive receiver assures maximum and uniform amplification on all wave lengths and establishes a totally new standard of tonal quality.

Hi-Q*: High Ratio of Reactance to Resistance. High ratio—great selectivity—loud signals.

JUST as Antonio Stradivari gave the priceless CUSTOM-BUILT violin to musicians of his day, so does Hammarlund-Roberts offer music lovers of our day the CUSTOM-BUILT Radio—

the advanced "Hi-Q Six" designed by ten of America's leading manufacturers—made with America's finest parts—incorporating every modern constructional feature—and built under your own eyes from plans so complete, so exacting and so clear-cut that the only outcome can be absolute radio perfection.

In addition to its unprecedented performance, the Hi-Q Six offers equally unprecedented economy, for by building it yourself you can save at least \$100.00 over the cost of fine factory-assembled sets. Complete parts, including Foundation Unit of chassis, panels and all wire and special hardware, cost only \$95.80.

The Hi-Q Instruction Book tells the complete story with text, charts, diagrams and photos. Anyone can follow it and build this wonderful instrument. Get a copy from your dealer or write us direct. Price is 25 cents.

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transformer secondary or one of the 0.1 mfd. buffer condensers, C5 or C6, is broken down. With the lamp still in the primary, the rectifier valve is inserted in the socket. If the secondary connections are O. K., and the Raytheon valve is operative, the lamp will increase in brilliancy. The buffer condensers, if suspected, may be disconnected from transformer secondary and rectifier socket, so as to be tested separately for short-circuits.

Testing the Raytheon Valve: A Raytheon valve can be depended upon to provide satisfactory service for about a year of normal use—at least a thousand hours of radio entertainment. After serving nearly its full life, the voltage output of the valve, previously maintained at a uniform high level, begins to drop off. When such a condition obtains, the voltage controls can often be adjusted to bring the voltage up again to the desired value, and many weeks more of good reception enjoyed before the valve is finally discarded.

If the Raytheon gets warm when the "B" power-pack is in operation, it is sufficient indication that the rectifier valve is operating.

Excessive Hum: This condition may be caused by an incorrect connection in the filter circuit, such as a condenser by-passing a choke coil. The hum should increase when either choke coil is short-circuited in turn. If the hum does not increase, the circuit connections to that choke coil should be checked, and if found correct then the choke coil should be replaced by another of similar characteristics. Make sure that one side of the "A" battery is grounded.

Importance of High-Resistance Voltmeter: Those desirous of operating a "B" power-pack or a Raytheon "ABC" power-pack, as the case may be, should have a voltmeter whose resistance is at least 100,000 ohms, with a full scale deflection of 200 or 250 volts. Such a meter will permit of adjusting the resistances for the proper output voltages when connected with a given radio receiver. Not only is this of great benefit when the initial installation is made, but it will later be of use in making adjustments to take care of line voltage fluctuations, changes of receiving valves, etc. Correct readings are impossible with the inexpensive, low-resistance type of voltmeter.

Motor-Boating, or troublesome low-frequency oscillations which cause fluttering in the reproducer, are generally due to conditions in the amplifier, and may be corrected by satisfactory adjustment of the amplifier.

Replacement Valves: It is of utmost importance that the existing rectifier valve in the power-pack be replaced by the same type of valve.

—LAURENCE MARSHALL



In the Still of the Arctic Night

In the still of the Arctic night, broken only by the occasional bark of a far-off walrus, the Radio Operator cannot leave his ship, frozen into the ice pack, and run around the corner to the Radio Shack for a new filter condenser to replace the one that just blew out.

He has got to be sure when he starts

that his equipment is not going to give out.

That is why Cliff Himoe took TOBE Condensers with him on the Bowdoin for the MacMillan Arctic Expedition.

Here is a Radio message just received from the boat: The TOBE'S are up to the mark!

"Your filter condenser standing up well on Bowdoin's transmitter, with no signs of trouble at continuous 2,000 volts dc; regards from the Arctic."

Himoe WNP

The University-of-Michigan-Greenland Expedition is also equipped with TOBE Condensers.

Make sure that your Radio Power Equipment includes TOBE Condensers. TOBE Condensers cure condenser worries permanently and painlessly.

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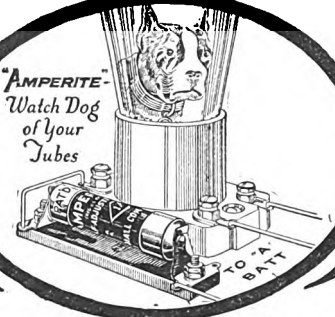


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Balkite "A" official "A" power supply for Hammarlund Roberts Hi-Q "Six" Receiver

Contains no battery in any form. Operates only during reception. Enables owner of Balkite "B" to make a complete light socket installation at low cost. Price \$35. Fansteel Products Co., Inc., North Chicago, Illinois.

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Insuring Tube Efficiency

AMPERITE alone gives utmost life and performance from tubes. Because AMPERITE alone keeps the filament voltage, or temperature, constant, despite "A" battery variations. Particularly needed with Battery Eliminators. Simplifies wiring and panel design. Eliminates hand rheostats and guessing. Proved for 6 years. Entirely different from fixed filament resistors. There is no alternative. Insist on AMPERITE. Price \$1.10 with mounting (in U.S.A.). At all dealers.

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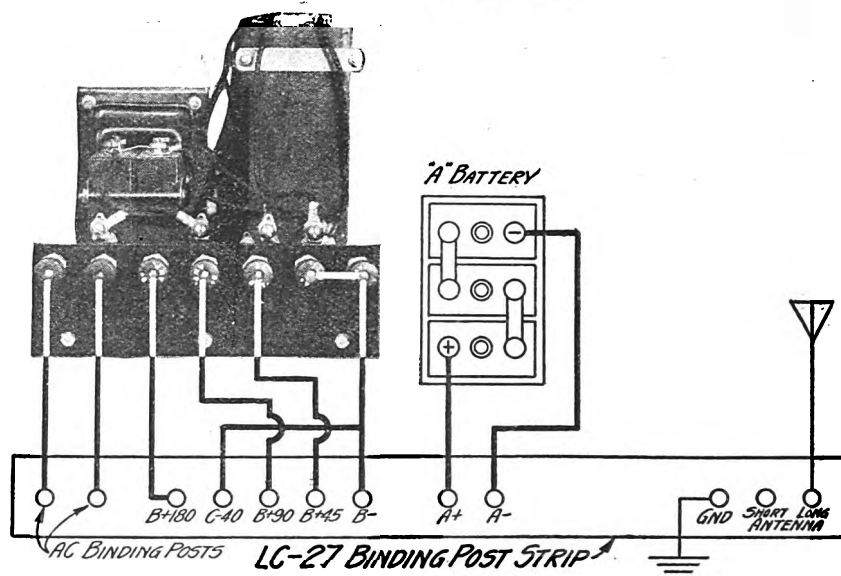
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The Pilot "BC" Power-Pack

(Continued from page 26)



"B" POWER FOR THE LC-27

FIGURE 3: The Pilot power-pack is here shown hooked up to the LC-27 receiver. The connections to any other standard receiver would be about the same.

wise with the filter condensers, H1, H2, H3, H4, H5, H6, H7 and H8, including the buffer condenser, G. These are to be strapped together with the threaded rods and fastened securely in place with four wood screws.

Now fasten down the two chokes, B and C, and the transformer, A, in the positions indicated in Figures 1 and 2. The last job will be to mount the socket, F, as shown in the same figures.

How to Wire the Set

This unit may be wired completely with the connection wire furnished by the manufacturer, without soldering. These connection wires are furnished in varying lengths equipped with lugs, and the resistors and condensers, the transformers and chokes, as well as the binding posts and the socket, are furnished with screw terminals, under which these lugs may be fastened tightly.

If these connection wires are used, and the circuit is wired exactly as is indicated in the picture wiring diagram in Figure 2, there will be no possibility of making a mistake.

The complete wiring job may be done in less than half an hour and the unit should then be ready for operation.

How to Use the "BC" Power-pack

The unit may be used with any five- or six-valve receiver, and a power valve of the 171 type may be inserted in the last stage of low-frequency amplification.

For illustrative purposes the diagram in Figure 3 shows the unit connected to the LC-27 receiver. The "A" supply may be furnished by a storage battery. In this diagram the unit is shown with

the wires running between it and the connection strip on the back of the receiver. The diagram also shows the connection for the storage battery and for the antenna and ground binding posts. A standard QRS rectifier valve is first inserted in the new "B" power-pack, and then the set is ready for operation exactly as before, except that the plug from the "BC" power-pack must be inserted in a 110-volt, 60-cycle AC lighting socket and the current switched "on." A Baldwin "99" loudspeaker is recommended with this combination.

In using the new power-pack with an ordinary set, the filament circuit of the power valve, which is the last valve, is cut off from the battery and a twisted pair of separate wires are run over to the two left-hand binding posts on the power-pack, as shown in Figure 3. This operates the last valve in the set on pure alternating current.

The only other change is that the "C" negative (—) terminal for the last valve in the set must be connected over to the "C" positive (+) binding post on the set, or to the "B" negative (—) binding post on the power-pack.

That's all there is to the job of installation. If a 4½-volt "C" bias is needed in the set, it will continue to be fed from a small Eveready 4½-volt battery, as the "BC" power-pack furnishes only the "C" battery voltage for the last valve.

This is probably the first description of a "BC" power-pack that will give really reliable results at such an extremely low cost. The unit may be relied upon to operate a standard receiver for years without trouble or without fussing with numerous complicated and bothersome adjustments.

The Soldering Science

(Continued from page 34)

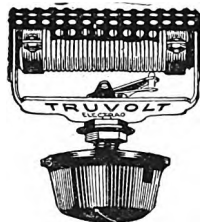
to a lug. The paste or fluid flux is usually applied to the parts; then the solder is applied from the point of a heated iron. If the flux be in paste form, the organic grease melts, allowing a certain portion of the suspended chloride solution to be deposited upon the work's surface, where it serves as the de-oxidizing agent. The remainder of the suspended chloride solution still held by the grease more remote from the point of heat application will be driven down or up our stranded conductor by the acceleration of the grease through heating. These chlorides find a resting place on the conductor strands under the protecting insulating material, where their removal is impossible. There the chlorides are able to start their destructive work unobserved and undisturbed. The action of fluid forms of flux will be found to be substantially the same. The boiling and spattering, caused from soldering heat, drive the chlorides under the protecting insulation with the same resulting conditions that follow the use of the paste.

Rosin for a fluxing medium possesses the distinct advantages of not being corrosive or conductive, as are the chloride fluxes. These two qualities are paramount in value for radio use. The striking lack of any tendency to promote corrosive action makes it a safe medium for use on the most delicate wire or part, and the lack of conductivity works in perfect harmony with insulation materials. It is not hygroscopic, and the residual matter presents a dense, hard and glass-like surface that does not favorably lend itself to the collection of moisture or foreign matter, as do the residuals of the chloride fluxes.

However, any attempt to use rosin or rosin-core solder on nickel-plated parts or connections will result in solder failure, for abiatic acid, the oxide solvent in rosin, has a negligible capacity for nickel oxide. Should it be necessary to make use of nickel-plated soldering contacts, file away the plating, and the base metal, usually brass, will respond to the fluxing power of rosin.

Rosin will display its greatest activity as a flux on metals plated with tin, cadmium, silver and gold or on unplated but reasonably clean copper, brass, or zinc. Electro tin-plated metals frequently show such a poor deposit of tin and the resultant heavy accumulation of sulphates and oxides that this treatment, unless properly executed, is of questionable relief. Hot tin dipped contacts will usually be found superior.

In the next article the practical uses of soldering will be described, with complete information as to the best procedure in making soldered joints in radio construction work.



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The sensational Hammarlund-Roberts "Hi Q" 'B' Supply Unit incorporates the Electrad "Hi Q" Truvolt Resistance kit. The kit has been especially designed by the engineers of Hammarlund-Roberts, Inc., and Electrad, Inc., exclusively for use in the "Hi Q" Six.

When building this unit, you are earnestly cautioned to use only the official Truvolt kit, as the values used were specially determined after considerable laboratory and research work. "Hi Q" 'B' Power Supply Unit Kit. List Price \$10.85.

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Samson Symphonic PUSH-PULL UNITS

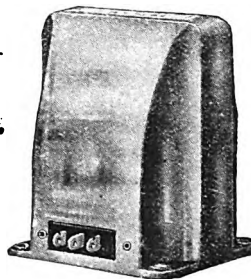
Clarify radio reception
as a Chemist filters liquids

Try this experiment. It probably will assist you to obtain better quality of reproduction.

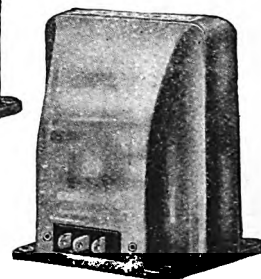
Listen to your set from three or four rooms distant while people talk and the usual house noises are present. Try to understand speech. Do you actually hear the s's and k's or does your imagination supply them? Can you recognize the high notes of a Stradivarius violin, or do all violins sound alike?

Now replace the audio transformers with the Samson Symphonic and Samson Symphonic Push-Pull Units. Listen again under the same conditions. *Words are now crystal clear and music has a background and a brilliance entirely new to you.*

Send for authoritative information from leading engineers which will be sent for about the mailing cost. Audio Amplification, 25 cts.; B Eliminator and Power Amplifier Construction, 10 cts.; Make-Em-Better Sheet, 5 cts.; and Inductance Units Bulletin, 10 cts. All four sent for 50 cts.



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Push-Pull
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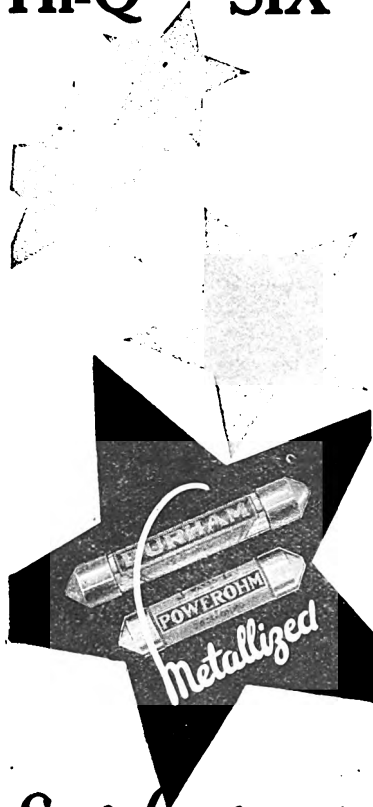


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Specified in the VICTOREEN and in the Hi-Q SIX



*Such Leadership
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WHEN foremost radio engineers—when leading set manufacturers—when successful professional builders—and when informed radio fans ALL endorse, adopt and use Durham Metallized Resistors and Powerohms, SUCH LEADERSHIP MUST BE DESERVED!

These famous Durham parts have won their indisputable position because over and over again they have proved their unflinching accuracy and absolute reliability where finest results are the ultimate aim.

If your receiver is not equipped with Durhams, a comparative test with replacements should prove why these products have lead their field for so many years.

Durham standard resistors are made in ranges from 500 ohms to 10 megohms. Durham Powerohms for "B" Eliminators and Amplifier circuits are made in 2.5 watt and 5 watt sizes in ranges from 500 to 100,000 ohms.

DURHAM
METALLIZED
**RESISTORS &
POWEROHMS**
INTERNATIONAL RESISTANCE CO.
Dept. A, 2½ So. 20th St., Phila.

What's New in Radio

(Continued from page 56)

tery economy is an important consideration. However, the 171 type valve provides the best quality of reproduction.

Any of the usual antenna and ground installations is suitable for use with the Bandbox. It will also function admirably with a light-socket antenna, such as the Dubulier Ducon. In localities close to several broadcasting stations, where there is severe interference, an antenna of from 50 to 75 feet in length is best. For more isolated localities the antenna length may be up to 150 feet.

Tuning is accomplished with a single knob, as explained. There are, however, two auxiliary controls in the form of toggle levers on the front of the receiver. Once these auxiliary controls have been adjusted they require no further attention on local or medium distant station reception. In receiving signals from extreme distances they are useful, but even then they are not at all critical in adjustment; and therefore do nothing to complicate the tuning. The only other control is a small knob which regu-

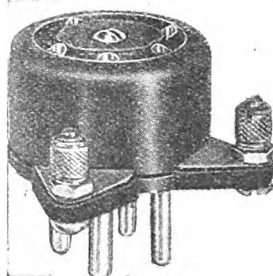
lates volume and provides a smooth control from maximum to inaudibility. There is also a switch knob for turning the receiver "on" and "off."

The decorative case which incloses the receiver is all metal and is finished in frosted, crystalline brown. It is attractive in form and finish and is the type of object that lends itself well to any kind of surroundings. The controls on the front of the receiver are all mounted on a burnished bronze escutcheon plate, which has a small opening near the top through which the illuminated tuning drum scale is visible.

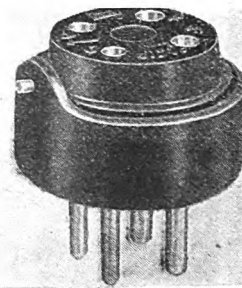
For those who prefer console cabinets there are a variety available, including low-boy and high-boy. There is also a cone-type reproducer that is a product of this same manufacturer and is admirably suited for use with this receiver.

Outstanding features: Excellent circuit design and construction. Complete shielding. Small size. Fine appearance. Meets all the requirements of a fine receiver at a low cost.

Maker: Crosley Radio Corp.



TYPE 927UY



TYPE 921S

A New Line of Sockets with Excellent Features

Name of instruments: Na-Ald vacuum valve sockets and adapters.

Description: The units comprising this new line of sockets and socket adapters are all of bakelite and will be described individually.

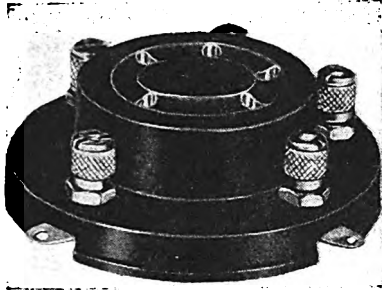
TYPE 927UY: This is an adapter for use in any receiver which is equipped with standard UX-type sockets and in which it is desired to use the new UY-227 five-prong AC valves. The adapter consists of a moulded bakelite block with four standard valve prongs on the bottom and with five holes in the top to take the new five-prong UY-227 valve. It also has two small extension arms and terminals for the AC heater current leads. To use it, the adapter is inserted in the standard valve socket in the receiver and the UY-227 valve is inserted in the adapter. The AC filament supply current leads are then connected to the extension terminals on the side of the adapter. By this simple means a standard receiver is readily converted to AC operation without changing the wiring of the set.

TYPE 921S: A cushion adapter for use with any standard UV- or UX-type valve socket, to prevent microphonic howls. This adapter consists of an outer shell with four standard valve prongs and a bayonet pin. Inside of this, on a cushioned support, is a standard UX-type socket top. The adapter is inserted in any standard UX- or UV-type socket in a receiver and the valve is inserted in

the top of the adapter. In addition to making any standard socket one of the vibrationless type, this adapter permits the use of the UX-199 or UX-120 valves in old-type sockets intended for 5-volt valves of the UV type. This adapter will stop howling in the detector of any set.

TYPE 427: This is a standard UY-type socket for mounting on top of a baseboard or sub-panel. It is small in size and sturdy in construction. Terminals take the form of both binding posts and soldering lugs. A decidedly advantageous feature of this socket lies in the grooved top which facilitates insertion of the valve, inasmuch as it is only necessary to allow the valve prongs to rest in the groove and then turn the valve until its prongs drop into their respective holes. This eliminates the annoyance usually attendant in inserting a valve in its socket, especially in the darkened interior of a cabinet receiver.

TYPE 425: This socket is similar to the type 427, except that it is for mounting on a sub-panel where the wiring is to be underneath the sub-panel. It is especially suitable for manufacturers of complete receivers. It requires that a hole slightly larger than the diameter of the body of the socket be drilled in the sub-panel. The socket rests down in this hole, with its terminals projecting through the under side of the panel. The mounting wings rest on the top of the sub-panel and provide the holes for

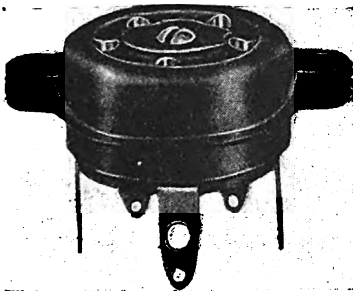


TYPE 427

the mounting screws. This socket also has the grooved top mentioned above.

Outstanding features: Excellent design and construction throughout. Unusual conveniences for the radio fan, whether he be one of the experimentally inclined type or a user of a standard commercial receiver. Especially interesting to the professional radio service man. All of these new sockets and adapters, except 921S, have a new feature, consisting of a guide ring that greatly facilitates easy insertion of the valves into the sockets.

Maker: Alden Mfg. Co.



TYPE 425

Moisture and Heatproof Fixed Condensers

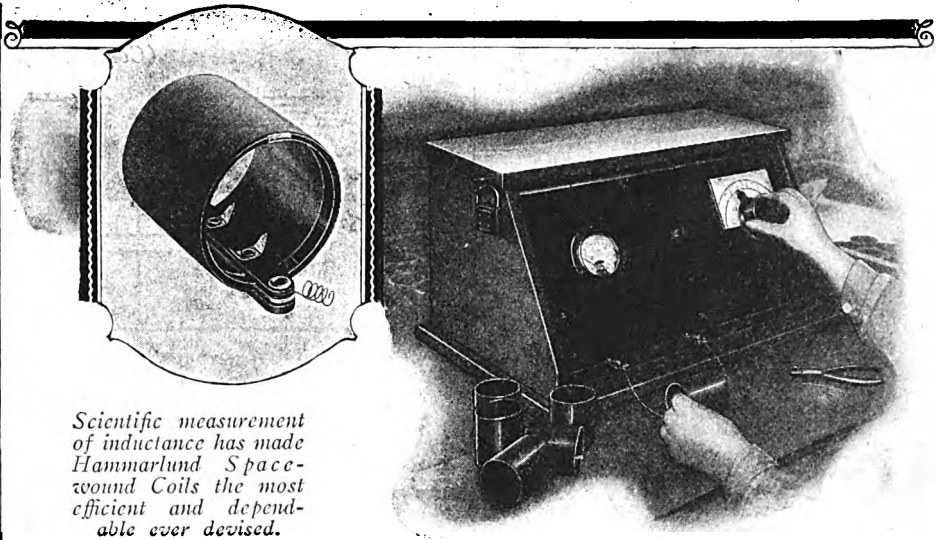
Name of instrument: Molded mica fixed condenser.

Description: These fixed condensers are made up of mica and foil, and are molded into bakelite blocks under heavy pressure. This bakelite covering insures permanent capacity values, and affords excellent protection against moisture and against the effects of heat when connections are being soldered to the terminal lugs. Capacities are guaranteed to be permanent and within 10 per cent of the rated values. Terminals are in the form of soldering lugs of convenient size and shape. The capacity value is clearly stamped in the bakelite covering of each condenser. Made in capacities from .00005 mfd. to .02 mfd. They are also made with grid-leak clips in two values, .00015 and .00025 mfd.

Usage: Wherever capacities of the values mentioned are required.

Outstanding features: Accurately rated. Permanent in capacity values. Moisture and heat proof. Equipped with convenient soldering terminals.

Maker: Carter Radio Co.



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- How Circuit Resistance Affects Selectivity.
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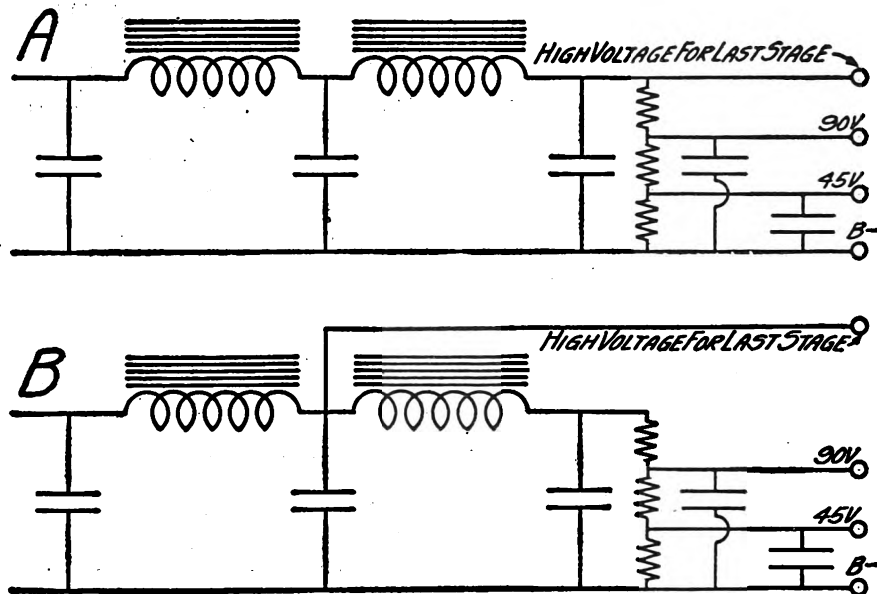
Send for folder
THE ACME WIRE CO., Dept. P
New Haven, Conn.

ACME WIRE

MAKES BETTER RADIO

Trailing the Elusive Hum

(Continued from page 52)



HOW TO RELIEVE OVERLOADED FILTER CIRCUITS

FIGURE 3: At the top is a standard power-pack circuit with two chokes, filter condensers, and the usual voltage dividing resistances. Under a heavy load, such as occurs when a large power valve is used in the last stage, the inductance of the chokes may decrease so as to let an AC ripple through to the receiver. If the high voltage for the last valve is taken off through only one choke, as shown at B, this source of hum may be eliminated.

The power transformer, the filter choke and the first-stage transformer must be kept a suitable distance apart to eliminate this trouble. A suitable spacing is indicated by the arrows in Figure 1. This distance can only be determined by experiment.

In considering a hum generated by the use of AC valves, the most common trouble is due to the fact that the heavy alternating currents flowing in the filament circuits are liable to induce similar currents in the amplifying circuits.

A remedy for this trouble is to twist all the leads running from the heater transformer to the heaters or filaments of the AC valves. If these leads are twisted, the alternating-current fields of the wires will be neutralized and no current will be generated in adjacent instruments or circuits. A well-done example of this type of wiring is shown in Figure 2.

It is also sometimes found necessary to twist the leads running from the secondary of the transformers to the grid terminal of the vacuum valve socket and to the "C" negative (—) connection, as shown in Figure 4. This also helps eliminate AC pick-up with its accompanying hum.

Some additional precautions that may be of help are the following:

1. Keep the antenna lead-in wires well separated from the house-lighting lines.
2. Don't stand a floor lamp near the amplifier or the receiver.
3. Don't run a reproducer extension

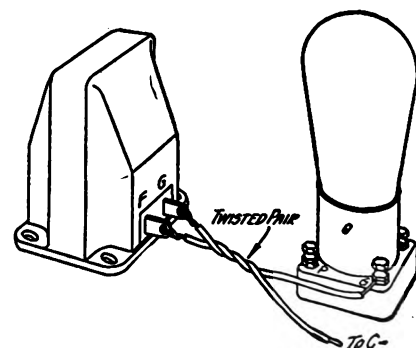
cord parallel with, or near, lamp cords or other wiring connected with the house-lighting lines.

4. Don't place the reproducer near the house-lighting lines or wires attached thereto.

5. Don't run long battery wires to either the "A" batteries or the "B" batteries down through the floor to the cellar, where they may come near the house-current meter or wiring.

6. Don't place any kind of power-pack too close to the set, either above it, below it or in back of it.

These simple precautions should be of help to the experimenter who is trying to get silent operation out of a modernized receiver and to the set builder who is constructing a set to be operated from the AC lines.



ANOTHER WAY OF KILLING THE VAGRANT HUM

FIGURE 4: Twisting the leads from the transformer secondary to the grid and "C" negative (—) connections also helps towards eliminating hums.

Making Radio Pay

(Continued from page 38)

modest supply of testing instruments, I would show my neighbors why their sets would not function properly and would suggest to them things that might be done to improve reception. In many instances, I would rejuvenate their valves free of charge, just to show them that I knew what I was talking about. By persistently following this policy, I had developed within a few weeks' time considerable business, and I found that my effort in establishing faith on the part of the users of radio equipment in my neighborhood was a good investment. I did not rush in and rush out, leaving a job half undone when I knew it was possible to get better results.

After I had accumulated a few dollars in spare cash, I had letterheads and business cards printed, and I would pass the cards out, not promiscuously, but to those people whom I knew would appreciate real, honest service and who had the money to pay for it. After that things came more or less easily, and each satisfied customer that I had worked for turned out to be a powerful influence in the way of advertising my service.

The next step in my growth came when I found myself able to establish credit with two local distributors. Now I have credit arrangements as high as \$1,000, which gives me more latitude for work and permits me to finance my work with less difficulty.

It is rather gratifying to look back and find that I have not as yet lost a single customer. I started with very few and now I have dozens of radio sets that I service regularly, some of them on a monthly payment basis. And the good will that I established has been built up entirely on trustworthiness and expertness.

First I determined that if success, even in a small way, should be mine, every service I did should be done with the same degree of effort as if I were doing it for myself; in other words, I determined at the outset to be an expert, to give expert service and with it expert workmanship, and to leave the satisfied customer to do my advertising. Also, and with emphasis, did I determine to use every customer openly and above board in all dealings. Upon these two qualities I have built my success.

Unfortunately, I do not have a sufficient command of words properly to impress the reader with the pure enjoyment that I have gotten out of my work and my little business. Some day I hope to be the recognized radio dealer in my home town, and if this dream comes true, it will have resulted from my sincere effort to give the people of Methuen, Mass., the best kind of radio reception that their receivers afford.

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1 Aerovox Moulded Condenser, .00025 mfd.....	.35	1 Durham Metallized Resistor, 6 meg.....	2.00
1 Aerovox Moulded Condenser, .00075 mfd.....	.40	1 Tait Brackets.....	.50
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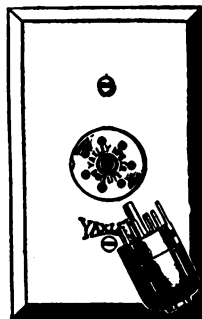
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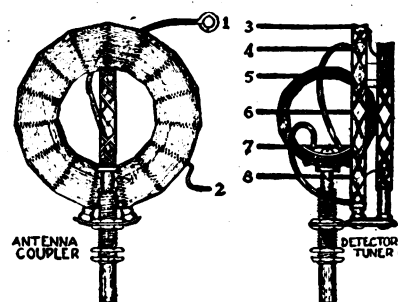
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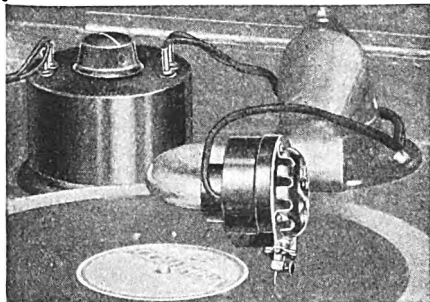
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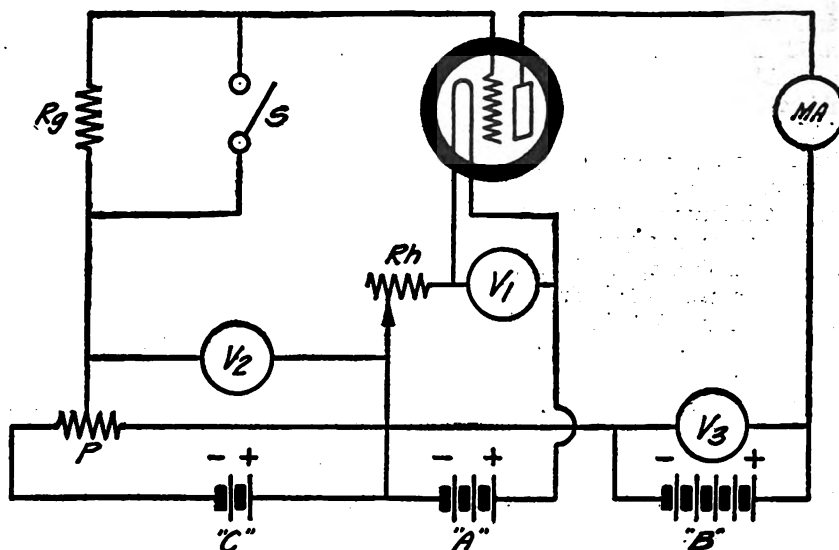
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W. A. Ready, Pres. Malden, Mass.

Write for Bulletin L-124

Measuring Grid Current

(Continued from page 50)



THE CIRCUIT USED IN GRID MEASUREMENT

FIGURE 4: This schematic hook-up of the instruments used in the grid tests shows the simplicity and practicality of the new method.

with the potentiometer and measuring the coincident plate currents with the grid resistance shorted by the short-circuiting plug S. If a grid resistance is now included in the circuit the plate current characteristic will be changed by the influence of the potential drop across the grid resistance, induced by the grid current flowing; up to the point of grid potential where grid current just begins to flow all the characteristics will be identical, but from that point they will diverge according to the value of the grid resistance in the circuit.

Figure 3 shows a group of characteristics taken in this way. It will be noticed that the higher the grid resistance is, the more does the curve diverge from the original valve characteristic taken with the grid resistance short-circuited. It will also be noticed that the point where grid current begins to flow lies at 1.3 volts negative grid potential with the Telefunken high-mu valve (mu 30).

The amount of grid current flowing can be taken from this group of curves in the following way:

The plate current at .5 negative grid volts and with the grid resistance short-circuited is .75 milliamperes, and this plate current is reached at about two volts positive grid potential, when a grid resistance of 26.9 megohms is in the circuit. Then the grid potential difference of 2.5 volts is divided by the grid resistance of 26.9 megohms to define the grid current flowing at .5 volts negative grid potential.

Figure 2 shows the characteristics of a special high-mu valve with a certain residue of gas.

It will be noticed that the characteristic taken with the grid resistance in the circuit rises above the one taken with the grid resistance short-circuited,

crosses the other at about 2 volts negative grid potential and then rapidly diverges to the right, showing much lower plate currents than the other. This rise, crossing and fall in the plate current indicates that up to 2 volts negative grid potential the grid current was negative, due to gas ions. At 2 volts negative grid potential the grid current was zero and from then on the grid current became positive due to the electron stream reaching the grid from the filament. Thus not only the amount of grid current but also its direction may be determined at a glance from the plate current characteristics taken by this new method.

Figure 1 shows a grid-current curve taken on the same valve by this same method.

It will be seen that (as was already to be expected from Figure 3) the grid current is negative and ionic up to 1.9 negative grid potential, where it becomes zero. At more positive grid potentials the positive and electronic grid current rises rapidly. Naturally, as becomes apparent from Figures 2 and 1, this method is also well suited for determining the vacuum factor of a valve.

From the curve given in Figure 4 the vacuum factor of that valve was determined as

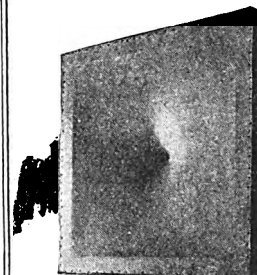
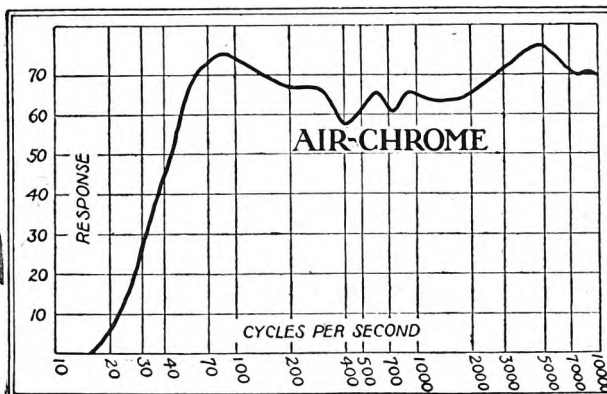
$$-\frac{Y_g}{Y_a} = 8.5 \times 10^{-6}$$

It can be seen that the method of measuring grid currents outlined above possesses many advantages, especially for the experimenter who does not have at his disposal the delicate instruments necessary for direct measurement. The accuracy of the method, however, is sufficiently great for all the ordinary needs of experimentation.

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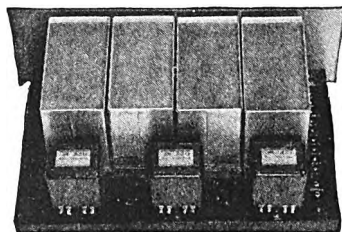
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25 Ft. Stranded Braidite.....35c
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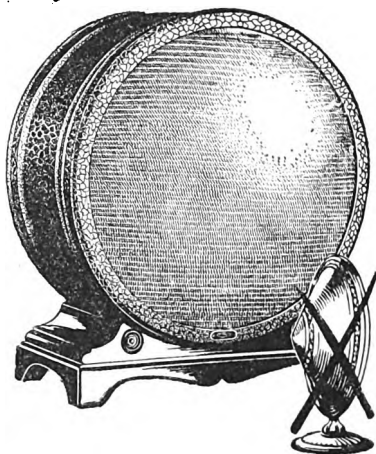
Made in red, green, yellow, brown and black.

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Because of its superiority, Braidite is specified in all the leading popular circuits of the day

The New TEMPLE

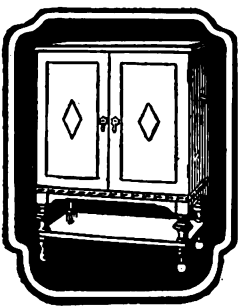


Air Column SPEAKER

Here is the speaker that has startled radio fans from one end of the country to the other. It is a development of the air column principle of tone reproduction. Acknowledged by leading speaker engineers to be the only method of accurately transmitting sound.

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People are amazed when they hear the Temple in comparison with the old type cone and other speakers which seemed fairly good a few months ago. But today is a new era in tone reproduction and Temple, thru this long air column principle, has given the entire radio world a new appreciation of radio.



Tone Quality

When you have heard the Temple speaker, you will agree with all others who have heard it that its clearness of tone, its volume and its depth surpass anything you ever dreamed was possible.

Priced at \$29.00 up

TEMPLE, INC.
1925 South Western Ave.
CHICAGO

The Harkness Counterfonic Six

(Continued from page 25)

red lines. - The high-frequency choke coil, G, should be hooked up as shown in the picture wiring diagram.

When all of the wiring has been completed, the grid-leak, S, should be inserted in its mounting, T, and the receiver is ready for installation.

Installing the Counterfonic Six

The receiver is now complete and should be inserted in its cabinet or console, according to the builder's taste. A 6-volt storage battery should then be connected to the binding post marked "A" battery positive (+) and the binding post marked "A" battery negative (-). These are indicated in Figure 5 as V3 and V4.

The vacuum valves recommended for this receiver are the new Televocal valves. Place three TC-201-a valves in sockets Y1, Y2, Y3 and Y5. Place a TC-240 type valve in socket Y4 and a TC-171-a type in socket Y6.

When this has been done, turn the filament switch, M2, to the "on" position by flipping it "up." All the vacuum valves should now light as the rheostat, M, is rotated in a clockwise direction.

Next disconnect the storage battery and turn the filament switch to the "off" position, then reconnect the storage battery between binding posts V3 and V6 and again turn "on" the filament switch. If the wiring has been correctly done, the filaments should not light. Then connect it again to the storage battery between terminals V3 and V7. The valves should not light here. Again disconnect the battery and connect it between V3 and V8. The vacuum valves should not light in this position when the switch is turned "on." This is a check to show that the "B" battery lines are not short-circuited with the "A" battery lines.

Next connect the 6-volt storage battery exactly as shown in Figure 5 and connect up the "B" batteries and the "C" batteries, as indicated in this diagram.

It is recommended, with this receiver, that an Electrad light-socket antenna be connected to the antenna binding post, B1, and that the ground, consisting of a wire leading to the radiator or the cold water pipe, be connected to terminal V2. With the large amplification obtained in this receiver, adequate reception may be accomplished without any outside antenna, although an outside antenna may be used if desired.

The reproducer should be connected, as shown in Figure 5, to the two binding posts at the right end of the set, looking from the front. The new Utah type reproducer has been found



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AEROVOX PYROHMS are built to last—are used by more than 20 leading power unit manufacturers.—This is conclusive evidence of their reliability—accuracy—worthiness.

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Earn \$500 in Spare Hours

Our members are making big money with Radio. Werner Eichler, N. Y., earns \$50 a week—Lyle Follick, Mich., has earned \$500—F. J. Buckley, Mo.—makes as much as he receives from employer—all in spare time. Our members are starting radio stores, getting better positions, increasing their salaries, earning money spare time.

Act Now—for No-Cost Membership

Send post card for details of Special Membership Plan that need not—should not—cost you a cent, and our book, "Your Opportunity in the Radio Industry." It will show you how you can cash in on Radio now—and later.

Radio Association of America

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Send me your book and details of your Special Membership Plan.

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City.....State.....

to work very satisfactorily with this set.

The set is now ready for use and the tuning operation is easy. Simply rotate the drum dial from one end of the scale to the other and the various stations will appear at their settings. Volume should be controlled by the lower knob operating the rheostat, M, in Figure 3.

The screws on the neutralizing condensers, U1 and U2, should next be adjusted for neutralization, and each may be set with a screwdriver at the position where no oscillation is encountered when turning the tuning dial from one station to another. These two adjustments will have to be set by experiment, but the neutralization is so simple that the proper settings may be found by even a novice within ten minutes' time.

The antenna switch, N1, may be tried in either the "up" position or the "down" position, according to the selectivity required. One position will be found to be broader in tuning and also louder and this switch should be used to suit convenience according to the location.

When the receiver has been in use for only a short period, the proper setting of the rheostat, M, will be found for the various stations, giving a reproduction that is truly lifelike in every particular.

I have one of these receivers at home installed in my study, and I get results that sometimes almost lead me to believe that I am in the broadcasting studio instead of by my own fireside. This new receiver, in my opinion, is by far the best that I have so far developed, and it should give many set builders and broadcast listeners satisfactory service and many thrills while listening to good programs.

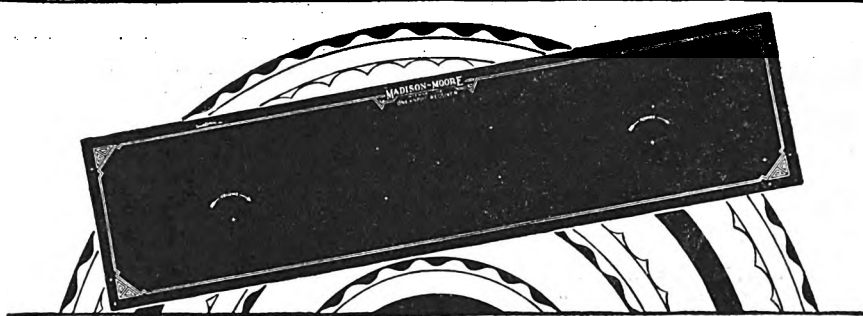
A Resistance-Coupled Amplifier for the LC-28

(Continued from page 30)

Prospective users of this device, in connection with the LC-28, will find that it gives more than sufficient volume with better tone quality and with more economical operation than are obtainable with any previous resistance-coupled amplifiers.

The complete installation is so easily done and the finished job has such a neat and businesslike appearance that it cannot fail to come into very popular usage among those who want the best in quality amplification.

The power-pack amplifier, of course, may be used with any other high-frequency pack or with an already constructed set or manufactured receiver to improve tone quality and to bring such receivers up to the standards of the best 1928 reception.



New FORMICA Kit Panels

RECENT additions to the list of handsomely decorated panels for famous kits include the Madison Moore International One Spot (A. C.) E. T. Flewellings Super Eight, and the new B*T Power Six Electric Kit. There are also front and sub panels for Karas (two dial), World's Record Super Ten; Camfield Nine; Tyrmann; Magnaformer, H. F. L. Victoreen and many others.

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Complete Insulating
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HOW TO BUILD A SIMPLIFIED A. C. RECEIVER

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The receiver is not only exceptionally easy to build, but it is inexpensive and contains standard parts that may be purchased at any retail store.

The booklet contains complete drawings, specifications and detailed descriptions of every step in the construction of the set.

The book is called HOW TO BUILD A FIVE TUBE A. C. RECEIVER, and it has been prepared by Laurence M. Cockaday, technical editor of POPULAR RADIO.

The price of the booklet is 25c postpaid.

Send all remittances to the

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Arthur H. Lynch, Inc.
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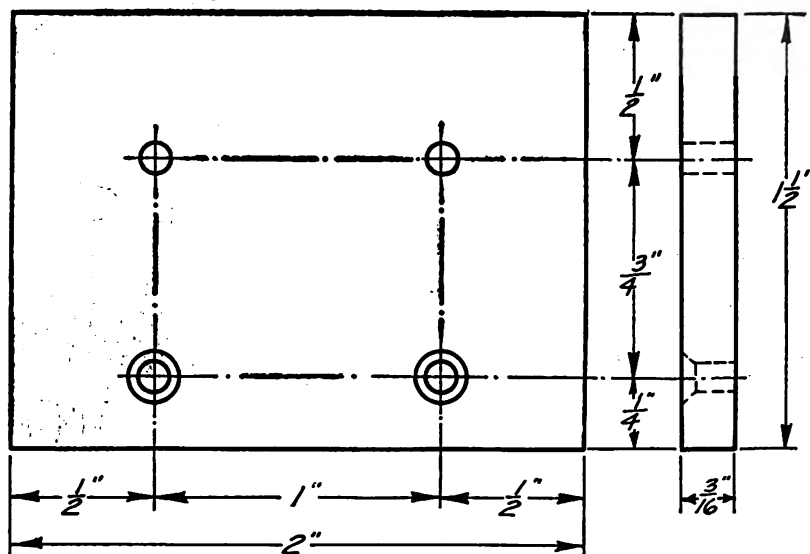
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Sales offices in most large cities

Power and Quality From the DC Lines

(Continued from page 42)



HOW TO DRILL THE PANELS

FIGURE 4: The two small panels for the binding posts, I1 and I2, and I3 and I4, should be cut and drilled according to the above layout.

cut the binding-post panels out of 3/16-inch Formica and drill according to the data given in Figure 4. Assemble the binding posts on the panels.

Refer to Figure 2 and the picture wiring diagram in Figure 3 when mounting the apparatus. Screw down the two sockets, D and E, with the plate and grid terminals towards the top of the baseboard, assuming the input of the unit to be at the left.

Place the push-pull input transformer, A, with the two terminals at the left and the three at the right and secure it to the base. Place the push-pull output transformer, B, with the three terminals at the left and the two terminals at the right and fasten it to the base.

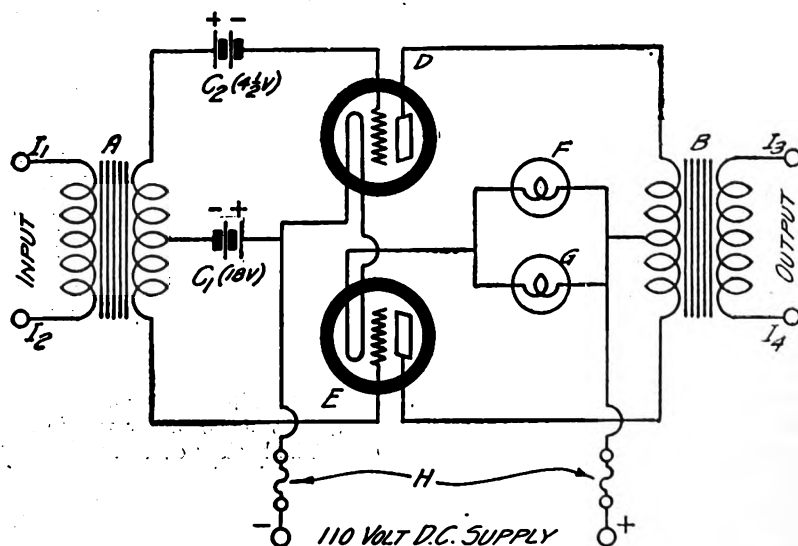
Secure the fuse block, H, at the left

of the base. Fasten the two porcelain receptacles, F and G, at the right of the base with their terminals at the lower left- and upper right-hand corners.

Using screws driven into the edge of the baseboard, mount the binding-post panels, J and K, so that the binding posts are centered with respect to the input terminals of transformer A and the output terminals of transformer B.

Wire up the amplifier exactly as shown in the picture wiring diagram in Figure 3. Place the "C" batteries in position and connect them in the circuit. From 16 1/2 to 18 volts will be the proper "C" bias for C1 and 4 1/2 volts for C2.

Connect to the fuse block a sufficient length of two conductor wire to reach



THE SCHEMATIC WIRING DIAGRAM

FIGURE 5: The push-pull arrangement shown here uses two Mazda bulbs, F and G, for resistances in the filament circuit. Ordinary resistances could be used instead.

the nearest lamp socket and put an attachment plug on the end of this wire.

How to Operate the Amplifier

Insert two CX-371-a type valves in sockets D and E. Place 15-watt, 120-volt Mazda lights in the receptacles F and G. Screw two 5-ampere fuses in the fuse block, H. A single Ward Leonard resistance (Cat. No. EB440) can be used in socket F if the light from the electric bulbs is found to be disagreeable.

At this point it might be well to mention that two 371 type valves can be used in this amplifier, and a single 60-watt, 120-volt Mazda light, or a Ward Leonard resistance (Cat. No. EB220) used in socket F.

Connect the input terminals, I1 and I2, of the amplifier to a cord with a plug and insert the plug in the radio set after the first low-frequency stage. If the radio set does not have a jack after the first stage, it will be necessary to disconnect the wires running to the plate and "B" positive (+) terminals of the last transformer and bring a lead from each of these wires out of the radio set to the corresponding plate and "B" positive (+) input terminals of the push-pull amplifier.

Connect the Amplion reproducer to the output terminals, I3 and I4, of the amplifier. Turn "on" the radio set with the battery switch. Insert the attachment plug in the 120-volt DC light socket, reversing this plug for the correct polarity, if necessary.

The amplifier should now operate continuously and should give an excellent quality of reproduction at suitable volume for home reception.

The 1928 Browning-Drake

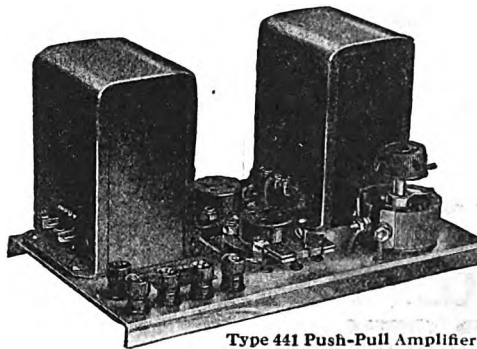
(Continued from page 18)

touching the finger to the stator plates of the second tuning condenser (the one to the right as one faces the set). The tickler coil should then be set back so that this circuit just goes out of oscillation. Adjusting the trimmer condenser will, if the set is not neutralized, throw this circuit into oscillation, which may be determined as mentioned above. Set the neutralizing condenser so that turning the trimmer condenser has no effect on the oscillation produced in the second circuit. The set is then completely neutralized.

The unit is designed especially to be used in connection with low-frequency amplifiers described in POPULAR RADIO magazine.

On pages 20-22 in this issue will be found the constructional details for a push-pull amplifier using two 210 type vacuum valves and a 227 type AC valve. This amplifier attaches readily to the two-valve tuner. The article on this unit incorporates complete operating details for the combination.

POWER and QUALITY



Type 441 Push-Pull Amplifier

A Push-Pull amplifier in the last stage provides the speaker with ample power to sustain a high volume level without tube overloading, transmitting the full effects of large swings in intensity common in orchestra music.

Type 441 Amplifier

For use with UX 226, CX 326, UX 171, CX 371, UX 210 or CX 310 tubes.

Input inductance.....30 henries

Input turns ratio.....1:2.25

Output impedance ratio.....10:1
(whole primary to secondary)

Price, completely wired.....\$20.00

Licensed by the Radio Corporation of America for radio, amateur, experimental and broadcast reception only, and under the terms of the R. C. A. license the unit may be sold only with tubes.

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MODEL "G"—Obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in superheterodyne and positive grid bias in all sets. Capacity range, Model G-1, .00002 to .0001 Mfd. Model G-5, .0001 to .0005 Mfd. Model G-10, .0003 to .001 Mfd. Price, each, with grid clips, \$1.50.

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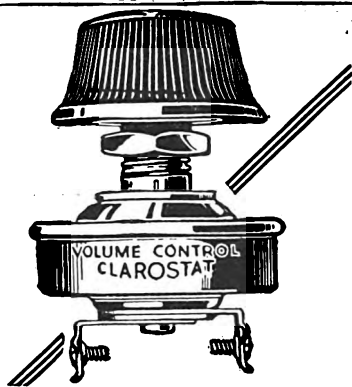
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And NOW the VOLUME CONTROL CLAROSTAT

A GENUINE Clarostat in a miniature, designed for light duty applications in usual radio set. Just the thing for control of volume, tone, regeneration, stabilization, plate voltage, balancing and many other purposes wherein limited current is being handled.

It does not, however, replace the Standard (20 watt) and the Power (40 watt) Clarostats for the heavy-duty requirements of radio power unit, line voltage control, and super-power amplifier.

THE Volume Control Clarostat has a resistance range of 0-500,000 ohms in several turns of knob, providing micrometric adjustment. Handsomely nickel-plated with new style bakelite knob. One hole mounting. Screw binding posts. And a real Clarostat through and through—noiseless, holds the adjustment, trouble-proof and durable. Best of all, the price—\$1.50.

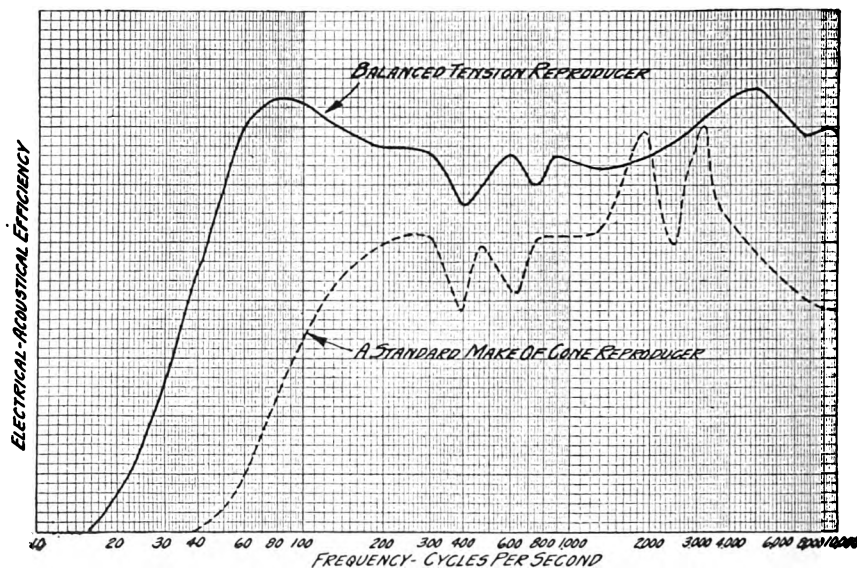
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Ask your dealer to show you the complete Clarostat line. Or write us direct for descriptive literature and technical data.

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Specialists in Variable Resistors
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A New Discovery in Loudspeakers (Continued from page 35)



THE AIRCHROME GETS THE LOW NOTES

FIGURE 2: The solid black curve shows the electrical-acoustical efficiency of the Airchome speaker over the audible frequency range. A comparison of it with the dotted curve of an ordinary cone speaker shows the superiority of the Airchome, especially on the frequencies below 100—the low note of reproduction.

proper tightness to be tuned to approximately 60 cycles, and the small stretched skin has a resonance at approximately 5,000 cycles.

Concentric waves are set up in the skins as the reproducer unit moves the combined apexes forward or backward, and the amplitude of this motion varies the tension in opposite directions for each of the skins, thus causing the resonant effect to slide along in both directions through the frequency scale. This action produces the reproduction curve shown in Figure 2. It will be noticed that the new loudspeaker covers the range over a wider area than other existing types of cone units.

In construction, the large skin is mounted upon a heavy square frame of well-seasoned wood, mortised at each corner so that it will not vibrate. The skin is then stretched tight by fastening it along each of the four edges. Two cross-pieces of heavy timber are then mounted between two of the opposite sides. These cross-pieces are held rigidly on the back of the large frame, and serve as two sides for holding the small skin. The two other sides of the small skin are mortised into these two cross-pieces. The small skin is then stretched tightly on the small square frame, and the two skins are drawn together at the center by the hollow fitting that serves to carry the compression lock nut. The lock nut fastens to the pin of the electro-dynamic unit that is used to operate the reproducer.

The unit itself is mounted on a rigid metallic frame that is, in turn, fastened securely to the two main cross-pieces that hold the small skin.

A front and back view of the two

stretched skins, with the reproducer unit mounted in place, is shown in Figure 1.

The unit that is used to operate the reproducer is of the balanced-armature type. It consists of a large, permanent magnet of high-quality steel mounted in a die-cast frame. The die-cast frame also holds the pole pieces and the windings through which the voice or music currents from the radio set are to pass. These currents set up a varying field that causes the balanced-armature to change its position and thus pull the pin in one direction or the other. The pin, in turn, actuates the two skins.

In external appearance the loudspeaker is dressed up to look like a small table with a decorated tapestry effect on the front and sides.

The reproduction afforded by this device, when used with the more modern amplifiers employing push-pull amplification with power valves, is truly a revelation. The new balanced-tension reproducer will handle more volume without distortion than any other type of loudspeaker now commercially available, and do it with a naturalness of tone in both the upper and lower ranges that is remarkable. The low tones of the drums are reproduced, if wanted, with the same full, robust and floor-shaking quality as if the listener were seated in the first row of the orchestra, while the high notes of musical instruments and the consonants of speech come through with startling definition and quality.

Engineers and experts who have heard and measured the new device have predicted a wide popularity for it.

The AmerTran Amplifier

(Continued from page 22)

posts. Then a twisted pair of standard No. 14 lamp cord leads should be connected from the two wires running to binding posts U5 and U6 directly over to the two filament terminals on the 5-prong socket, N. A twisted pair must be used here in order to eliminate any stray AC field that might otherwise be generated by the AC current flowing to the filament (heater) of the AC valve that is to be used in socket N.

All the rest of the wiring, except one short lead, may be done, as stated before, with Braidite and should follow the connection scheme given in detail in the picture wiring diagram in Figure 2. The wire leading from the binding post, U3, to the movable arm of the potentiometer, T, is the exception and should be made with flexible stranded rubber-covered wire. The 750-volt tap on the transformer, A, is not used and should be taped up.

In the picture wiring diagram all of the instruments and parts are outlined in black lines and the wiring is shown in solid red lines, except where it passes underneath an instrument, and here it is indicated by dotted red lines. All of the leads should be separated a short distance so that actual contact between two crossing wires is eliminated. A suitable length of twisted lamp cord should be connected to the terminal marked "O" and the terminal marked "120" on the primary side of the transformer, A. All the other primary leads should be taped up. A lighting plug should be attached to the other ends of the lamp cord for plugging the amplifier into the lighting lines.

When the wiring has been completed, each lead should be rechecked throughout all of the wiring for mistakes, so that the builder makes sure that it is correct before the amplifier is placed in operation. When this has been done, the unit is ready for installation.

Installing the Unit with the 1928 Browning-Drake

First of all, place the Browning-Drake receiver in the cabinet or console chosen for it, and install the push-pull power-pack amplifier underneath, in the radio compartment. Then make the connections between the power-pack and the Browning-Drake high-frequency pack, as indicated in the combination diagram in Figure 1. It will be noticed, in this diagram, that one binding post on the Browning-Drake unit is left unused. The two sets of twisted leads from the Browning-Drake set are connected to the binding post on the power-pack amplifier as indicated.

The ground wire is also put on, as well as a socket antenna unit; that shown in Figure 1 is a Tidmarsh "Sock-Antenna." Of course, an ordi-

nary outdoor antenna may be used here if desired.

A Belden extension cord is connected to the output binding posts, U9 and U10, on the power-pack amplifier. This is connected over to the Air-Chrome reproducer, which should be placed, for best results, on the other side of the room.

There are no batteries whatsoever required for this hook-up.

Place two CX-327 type valves in the two sockets in the Browning-Drake high-frequency pack. Then place another CX-327 type valve in socket N of the power-pack amplifier. Place two CX-310 type valves in sockets O2 and O3 of the amplifier, and finally place a CX-381 type rectifier valve in socket O1 of the amplifier.

The complete installation is now ready for operation. Turn the main knob of the potentiometer, W, in the half-way position and turn the main knob of the potentiometer, T, three-quarters of the way in a clockwise direction, and turn the extension arm of the potentiometer, T, to about the half-way position. This is the arm that controls the "C" bias for the high-frequency valves in the set. These are approximately the correct settings for these instruments, when used with the valves that have been recommended in the above hook-up.

Next place the extension lamp cord and plug that has been connected to the primary of the transformer, A, in a nearby lamp socket and turn "on" the switch. The valves should then begin to heat up and after a period of about 15 or 20 seconds the set is ready for use and the tuning may proceed in a normal manner, with the main dial of the Browning-Drake receiver tuning the wavelength and the small left-hand dial being used for vernier setting, while the upper right-hand small dial is used for sensitivity and the lower left-hand small dial is used to control the volume of reproduction.

The complete installation should give exceptionally fine results for broadcast reception. On account of the elimination of all batteries, and the total operation from the lighting lines, it should also be of great interest to all radio set builders.

The complete unit when used with the recommended reproducer will furnish a quality and volume of reception that is truly astounding in its naturalness. Any volume may be obtained from the whisper of a violin to the swell of a great organ without the slightest sign of distortion. Future articles will tell how to use the power-pack as an amplifier with the LC-28, with other sets, and also for quality reproduction from phonograph records.

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THE new Harco Catalog should be in the hands of every set builder and dealer in radio. It lists thousands of standard radio items at prices that will astound you. Complete sets—accessories—all the latest kits—a complete line of parts and an assortment of radio furniture that will satisfy the most discriminating—all at rock bottom wholesale prices.

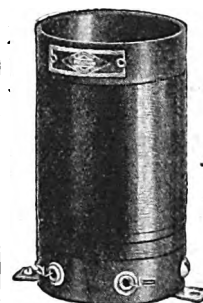
Set Builders

All the latest and popular kits are listed in the Harco Catalog at genuine wholesale prices. Be sure to get a Harco catalog before you place the order for your kit.



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1255 S WABASH CHICAGO ILL

PRECISION ANNOUNCES



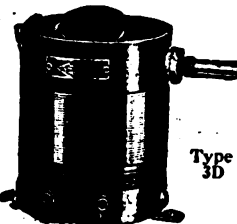
Type 4F

A Tuned R. F. Transformer with Tapped Primary (.00035 Condenser)

Here is another need supplied. Accurate to 1% of the rated inductance. Space wound on bakelite tubing, assuring you the best possible coil. Type 4F. Price \$2.50.

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Type 3D

PRECISION COIL CO., Inc.
209 CENTRE ST. NEW YORK, N. Y.

The Victoreen "Super"

(Continued from page 41)

down to the baseboard, V, by two small wood screws. The audio control unit, G, is also fastened down with two long wood screws of suitable length to grip firmly into the baseboard, V.

The antenna connection block, X, is first cut out of $\frac{1}{8}$ -inch micarta to a size of 3 inches by $\frac{5}{8}$ inch, and is drilled with six equal-spaced holes for mounting the four jacks, S1, S2, S3 and S4, and the two mounting lugs. These consist of brass tubing 1 inch in length, through which are screwed two long brass wood screws directly into the wooden base.

The decorative wood panel, U, is already cut and prepared and on it the various instruments are mounted. The drum dial, T, is fastened on it according to the instruction sheet packed with the dial. The rheostat and potentiometer, L and K, are mounted as indicated in Figure 2. The antenna change-over switch, H, and the pilot light, W, are also mounted as indicated in this diagram.

The two condensers, E and F, require for mounting two pieces of micarta, X2 and X3, cut to sizes of $3\frac{1}{2}$ by $1\frac{1}{4}$ inches. Each condenser is mounted by screwing two flat-head screws to the micarta pieces and into the two bottom holes in the frame of the condenser. The bottom side of the micarta panels must be countersunk so that the heads of the screws will set flush. Then the two condensers, E and F, are placed in about the positions shown in Figure 2, with the shafts inserted into the coupling units on the dial, T. The screws of the coupling units are tightened, the two condensers lined up, and the micarta bases, X2 and X3, then fastened by means of two screws, each in the correct position so that the dials turn freely. The construction work on the set is then complete, except for mounting the condenser, Q; the condenser, M2; the grid-leak, O2; the condenser, N1, and the grid-leak, O1, which are supported by the wiring and are fastened at the time the wiring is done.

How the Receiver Is Wired

All of the wiring in this set is done with regular bus bar, except where there is a possibility of short-circuit; standard solid celatsite is used in these places. The wiring of the set is done exactly as shown in the picture wiring diagram in Figure 2. In order to keep the filament wiring from short-circuiting, soldering lugs are placed under the positive (+) terminals of all the sockets, and each lug is turned at right angles so that a single length of bus bar is passed through the soldering lugs, making connection for all eight sockets. All of the wiring to the Yaxley cable

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NOTICE PROFESSIONAL SET-BUILDERS

POPULAR RADIO is preparing special information which will be of great value to professional set-builders throughout the United States. Those who desire this information may have it, free of charge, by addressing a letter of inquiry to the Service Department and answering the following questions:

1. How many sets do you construct each year?
2. What receivers are you specializing in?
3. What do you spend for radio parts each year?
4. How long have you been in business?
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plug is done with celatsite. Care must be exercised in wiring the audio control unit, so that possible short-circuits will be avoided.

Installing the Victoreen Super-heterodyne

The set itself is placed in a Corbett type C chest and connected up with the loop antenna, as shown in Figure 4. The two loop wires are connected to the terminals, S1 and S2, on the antenna connection strip, X1.

An Electrad socket antenna may be used and connected to terminal S3, with the ground wire connected to the water pipe or radiator on terminal S4. A socket antenna works extremely well with this receiver, although a regular outdoor antenna may be used, if desired.

The loudspeaker that was used in the laboratory was a Temple exponential type reproducer and its tip jacks are connected to terminals S5 and S6.

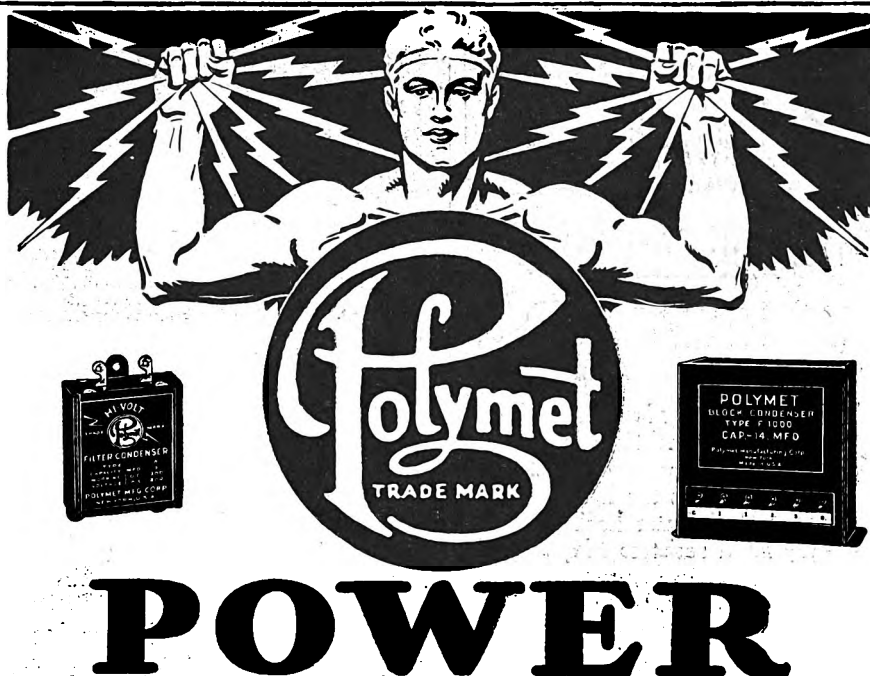
Three standard 45-volt "B" batteries are connected to the Yaxley cable leads, as shown in Figure 4, as well as three 4½-volt "C" batteries, one of which should have the 3-volt tap.

Place six CX-301-a type valves in the first six sockets and two CX-312 type valves in the last two sockets in the set.

For the "A" power, the most satisfactory solution for this receiver, using eight vacuum valves, is to use an "A" power-pack to do away with battery charging. One that has shown exceptional qualities for this high current drain, without the slightest sign of hum, is the new Knapp "A" power-pack, which may be obtained in kit form and which is described in detail in another article in this same issue. This unit is shown connected up in Figure 4. When the set is installed, exactly as shown in the instructions in this diagram, it gives very fine results from a tone quality basis, as well as being capable of bringing in distant programs with clarity and volume.

All of the tuning is done with the two middle drums on the illuminated dial, while the knob at the right is used for sensitivity, and the small dial at the left is used for turning the set "on" and "off." The pilot light, also at the right, indicates this condition at a glance. In using the set the Vee-coil antenna should be rotated to bring in the station desired with loudest volume. This, in itself, is a great help in eliminating interference from two stations on adjacent wavelengths, the signals of which come from two different directions.

The set has been working for the author for the last three months in a most congested metropolitan area without once giving the least bit of trouble from interference.



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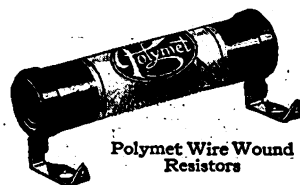
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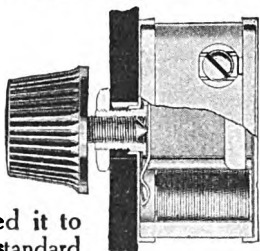
Bradleyunit-A



This fixed resistor is scientifically treated to resist moisture. It is not affected by temperature, moisture or age. Provides the ideal resistance for B-eliminator hookups requiring fixed resistors of quality.

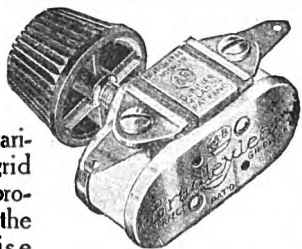
Bradleyohm-E

The remarkable accuracy of the Bradleyohm-E has caused it to become standard equipment for accurate plate voltage control on many leading B-eliminators. Use it on your power-unit hookups.



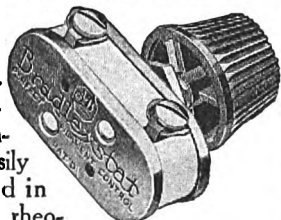
Bradleyleak

This variable grid leak provides the precise grid leak value for best results with every tube. Try it on your set and notice the greatly improved reception.



Bradleystat

The perfect filament control. Easily installed in place of rheostats now in service. Gives noiseless, stepless filament control for all tubes. Use Bradleystats on your next set.



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LISTENING IN

PRACTICAL pointers from experimenters and broadcast listeners. What helpful hints can YOU offer to your fellow fan? Readers are invited to address their letters to the Editor of this Department.

CONDUCTED BY DAVID LAY

Old Automobile Batteries May Be Used With the Radio Receiver

AUTOMOBILE storage batteries are usually made with heavier construction than those designed for radio work. The automobile battery receives severe usage and is usually discarded when it fails to turn the starter over snappily. The discarded battery will often be found to be suitable for the radio set, since radio service is less exhausting.

Most cars use a 6-volt battery—the same voltage that is used on radio sets. The storage battery voltage can be determined by counting the vent gaps—one to a cell. Each cell yields 2 volts, and they are connected in series to add up to 6 volts. The Dodge and a few other makes have a 12-volt battery (6 cells); to use one of them on a radio, you would have to make a tap at the center and use half at a time.

Be sure about the polarity, if you haven't a voltmeter to tell it to you. The positive is always the dirtiest terminal. Mark the polarity by scratching plus and minus signs on the wax coating.

Clean the battery thoroughly—a good wash with soap and water and scrubbing brush outdoors will do the job. To make contact with the terminals it is advisable to use regular battery clips.

You won't be able to charge the old automobile battery fully, but you will get a year or more of service out of it.

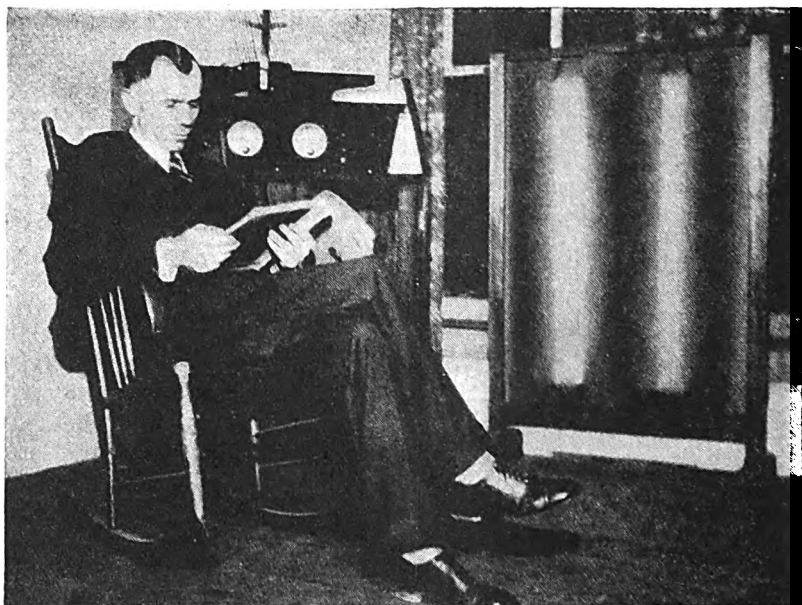
—LAURENT L. JACQUES, *Toutes Aides, Manitoba*

* * *

How I Built a Roll-Type Reproducer

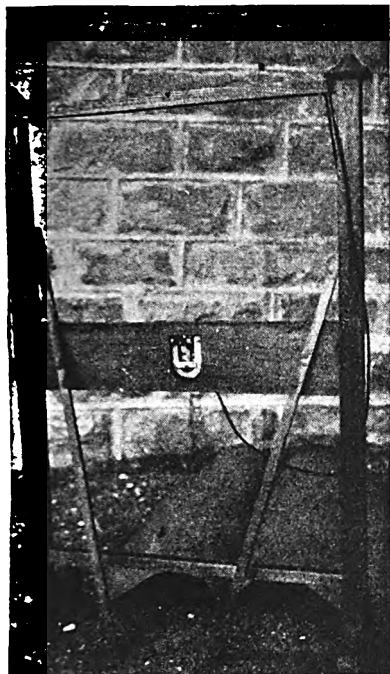
HAVING tried most of the various types of speakers, I decided that there was a possibility of building one myself that would suit me better.

I chose the roll type, as it would lend



THE ROLL REPRODUCER IN USE

With a tasteful finish on the paper rolls and the wooden frame, this reproducer may be made into an interesting addition to the furniture of the radio room or library.

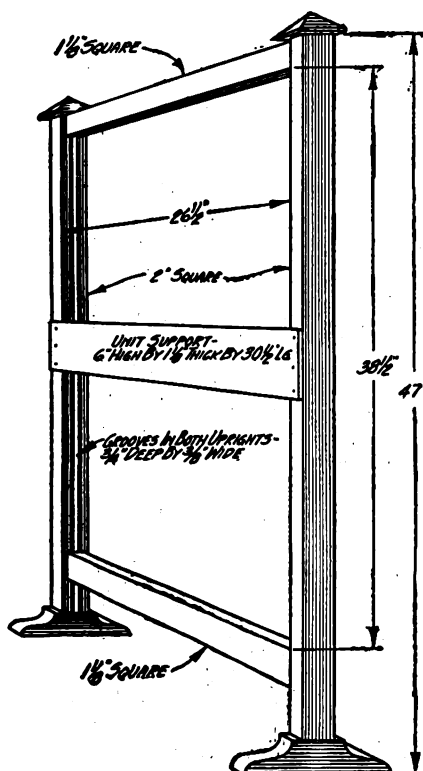


THE ROLL REPRODUCER READY FOR MOUNTING

FIGURE 1: The two strips leaning on the frame are to be pressed into the grooves to keep the edges of the roll in position.

itself more to my room than other types. But after building one of the conventional weight and shape, I found that if it were hung on the wall it would beat a tattoo and if allowed to lean against the wall and rest on the floor, it would dance a jig. So I decided to build one according to my own ideas.

I found that a light framework would not do, as the roll was so large as to



THE FRAME FOR THE ROLL

FIGURE 2: The heavy construction is necessary to prevent vibration.

NEW!

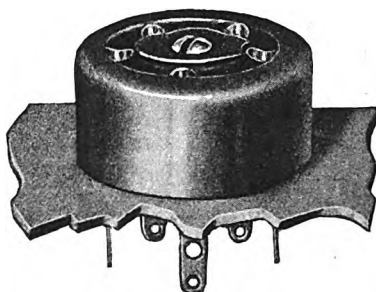
NA-ALD A.C. SOCKETS

(Patented)



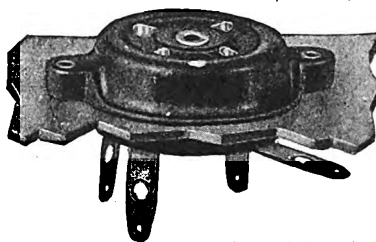
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For 5 Prong UY 227 Tubes



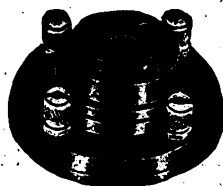
No. 423

For 5 Prong UY 227 Tubes



No. 424

For UX 226 and all UX Brass Tubes



No. 481XS

Note automatic oscillation controls, automatic locator rings and special contacts.

A socket is not just a socket—not for AC tubes. The new AC tubes draw up to $1\frac{3}{4}$ amperes. They therefore need the firm, full length contact of Na-ald parallel constant - pressure contacts. The A. C. contacts must also be on the outside of the tube prongs. They need to be sturdy, firm and of sufficient cross section to carry the current. "It's the contact that counts."

IMPORTANT—Na-ald sockets and the new locator rings are covered by patents and patents pending.

Na-ald A. C. sockets are not an adaptation of a battery socket, but are designed particularly to meet A. C. requirements. Note the automatic locator ring; colored for easy visibility and to indicate the type of tube to put in each socket. Green for No. 227 or detector tube, red for No. 226 or all purpose tubes and orange for the power tube. The locator ring makes it possible to aim the tube at the locator ring, close your eyes, turn the tube and it slips smoothly and easily into place. It removes as easily with no clinging springs to jar the heater and shorten its life.

Resistor jacks are incorporated in No. 422, No. 424 and No. 426. Grid resistors or suppressors slip into these jacks or slots and connect in series with the grid prong and the rest of the circuit. When resistor is removed the circuit is automatically closed. See page 3 in the Na-ald book "What to Build" for list of values of resistances.

Na-ald contacts are nicked phosphor bronze alloy rolled to our specifications. These specifications are the results of the experience and study in the making of millions of socket contacts. Na-ald sockets are made for the set-constructor laboratory, engineers as well as for the largest commercial set manufacturer.

Write today for the story on Na-ald A. C. sockets and booklet "What to Build."

ALDEN MANUFACTURING CO.

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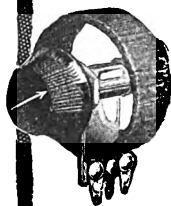
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Here are the new Centralab units designed especially for use in socket power circuits to carry continuously an unusually heavy current for their size, providing smooth acting control under all conditions.

Centralab Power Rheostat is warp-proof, heat-proof, permitting continuous operation at temperatures of 482° F. and beyond. Resistance wire is wound on metal core, asbestos insulated. Core expands with wire, insuring smooth action. Narrow resistance strips give small resistance jumps per turn, further insurance of even regulation. Compact 2" diameter, 1" behind panel. Ohms—500, 250, 150, 50, 15, 6, 3, .2, .5—price \$1.25.



POWER Centralab Potentiometer

This new unit is identical with the Power Rheostat except for an additional terminal, and is especially suited to obtain variable voltages for detector tube and variable "C" bias in socket power circuits. 15, 150, 250 ohms, **\$1.50**; 2,000, **\$1.75**; 5,000, **\$2.00**.

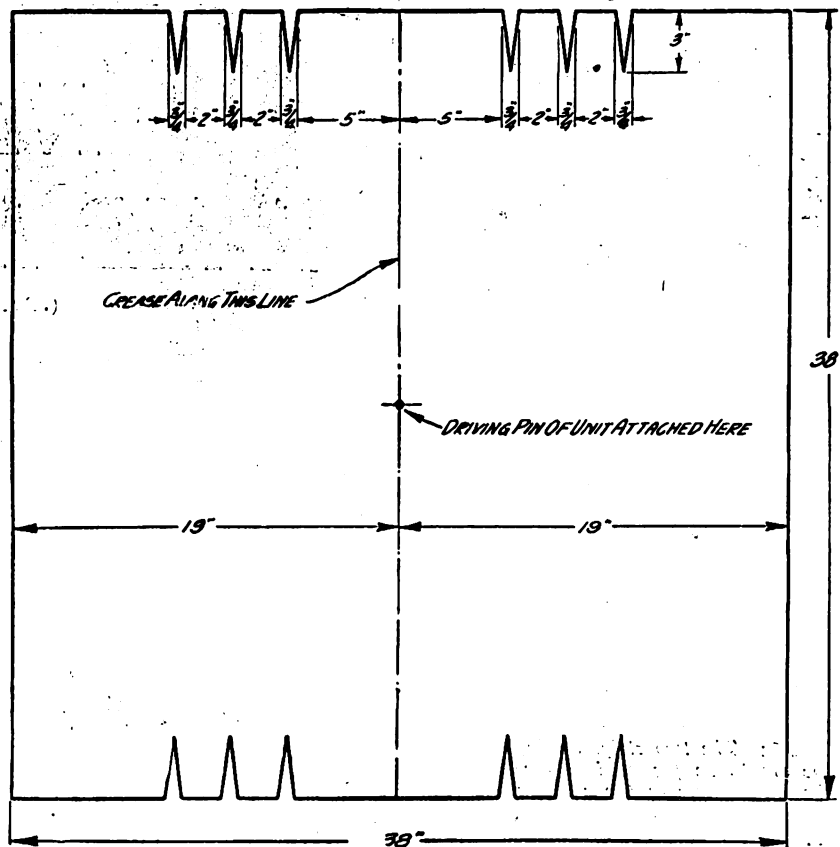
4th TERMINAL Centralab PotentiometerR

With an added semi-variable contact arm, this new potentiometer is identical to the above units. The 4th terminal is adjustable behind panel to any resistance value. 175 ohm unit gives 2 variable voltages in ABC power circuits. 250 ohms is used with the new Raytheon ABC. The 2,000 is used for "C" bias in such circuits as Amer-Tran Power Pack. Two 6,000 ohm units in series across output of a "C" eliminator gives possible voltage regulation 15, 250 ohms, \$2.00; 2,000, 3,000, 6,000, \$2.25.

At your dealer's, or C. O. D.
Send for new ABC power
circuits and circuits for im-
proved B power control.

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Centralab



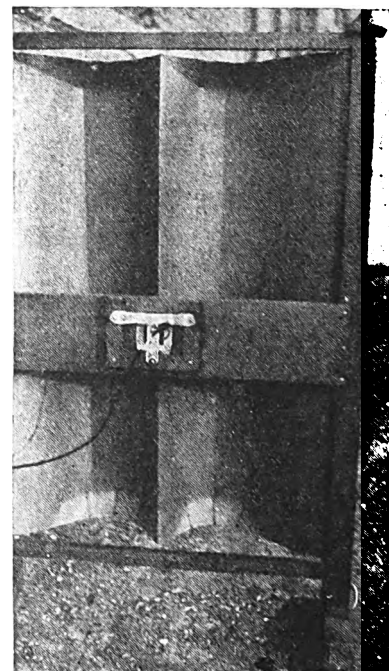
THE DIMENSIONS OF THE PAPER ROLL

FIGURE 3: The roll should be cut along the solid lines around the edge and creased along the broken vertical line in the center.

cause the frame to vibrate; and if the frame were not attached rigidly to some object large enough to hold it, it would make a noise due to the vibration of the frame against the object with which it was in contact. I also found that it was impossible to tack the edges of the roll to the frame and not have the edge vibrate against it.

The framework was made heavy, especially the base and upright part, as was also the cross-piece that supports the driving device. A glance at the framework shown in Figure 2 seems to show it as rather cumbersome, but it is none too heavy for good operation. In fact, if it were heavier it might be better. The two vertical sections of the frame are 2 inches square. The top and bottom cross-section are $1\frac{1}{8}$ inches square, while the unit support cross-section is 6 inches by $1\frac{1}{8}$ inches dimensions. The base pieces and the two top corner caps, while not so easily made, add much to the appearance of the speaker. All joints are mortised and glued. The upright pieces are grooved to receive the edges of the roll. The groove is $\frac{3}{4}$ inch deep and $\frac{3}{8}$ inch wide. Two strips are made the exact size of the grooves, beveled so that when viewed from the end they will look like keystones; they are pressed in behind the rolls. Figure 1 shows the strips leaning on the frame. The base pieces are fourteen inches long. They were carved from stock a little heavier than two inches.

The roll is made from one piece of Alhambra Fon-o-Tex, 38 inches square. The roll is cut out according to the dimensions shown in Figure 3, and creased along the center. This is done by drawing a line through the center with a fingernail file, lengthwise with the way that it comes off the



THE DRIVING MECHANISM

FIGURE 4: The heavy board supporting the reproducer prevents the framework from vibrating with the reproducer.

roll. It is now folded and the crease is pressed with a cold iron. Midway along this crease the operating device is attached, as shown in Figures 1 and 4. I used a Western Electric unit. After the frame has been completed and the roll thus far made it is placed in the frame and six triangular sections taken out of each end; the edges are then brought together and glued. The pieces which are cut out are $\frac{3}{4}$ inch by 2 or 3 inches. The armature is now attached, and you have a speaker that is inferior to none.

—B. G. TILLEY, *Matoaka, W. Va.*

A Handy Test Meter for the Trouble Man

BURNED-OUT low-frequency transformers are one of the most common causes of receiving sets going "dead"; so this description of an instrument to test them should be of interest to the trouble man. In locating trouble in a receiving set that will not work, the proper procedure is to test the "A," "B" and "C" batteries; see that the aerial and ground are properly connected to the set; then test the valves, if a valve tester is available. If all of these things are all right, the trouble must be in a broken or burned-out connection.

An instrument that is of the greatest aid to the service, or "trouble," man, and to the set owner himself, is a pocket combination ammeter and voltmeter, which retails for about \$2.50. This meter has two ranges: zero to 35 amperes and zero to 50 volts. It has three terminals: one terminal for one ammeter connection, one for one voltmeter connection, and a third terminal that is common to both ranges. Although this instrument is not very accurate, it is good enough to use for checking batteries. It can also be used to test for open circuits, and for burned-out transformers and loudspeakers, by connecting the voltmeter range of the meter in series with a "B" battery. To do this, one terminal of a 45-volt "B" battery should be connected to one terminal of the voltmeter, and test leads attached to the other terminal of the "B" battery and the other voltmeter terminal. The polarity of the "B" battery must be right for the voltmeter. If the two test lead terminals are touched together, the voltmeter should read 45 volts. To test a transformer, these two test leads should be connected to the ends of each of the transformer windings in turn; and if either winding will not allow the voltmeter to read, it is burned out.

The voltmeter will not read 45 volts when connected through a transformer winding—unless the winding is short-circuited—but some value determined by the transformer's resistance.

—CHARLES C. FELSTEAD,
Los Angeles, Cal.

The TRUTH about A.C. OPERATION

The term "engineering" has been grossly and frequently misapplied to the design of radio parts. Engineering in the modern, American sense, indicates the development of methods by which, in the quickest, least expensive way, the specifications of a given result can be met profitably. On this basis, the PILOT ELECTRIC M'FG. COMPANY is one of the very few radio parts manufacturers whose products represent the application of modern scientific and industrial engineering.

THE high cost of A. C. operation is due entirely to the extravagant and makeshift methods employed by radio parts manufacturers, and the costly merchandising channels thru which the apparatus is sold to you.

You should be able to buy parts for a complete power pack for A. C. tubes at about the price you have been paying for four big B batteries. You should be able to buy the parts for a 5-tube receiver and eliminator for complete A. C. operation at the cost of the usual B power packs.

And you can—if you buy PILOT Precision parts. If you can't get PILOT eliminator equipment in your city, write to M. B. Sleeper, Chief Research Engineer of this Company and he will tell you where to get PILOT Precision parts.

PILOT production and design are controlled by a great staff of industrial and radio engineers for, since 1908, PILOT has grown to be the largest radio parts plant in the world, employing 1,000 workers, with offices and representatives in practically every foreign country.

Production of such magnitude, with resultant economies, makes the cost so low that you can buy PILOT Precision equipment at what you would otherwise pay for the cheapest parts.

PILOT ENGINEERING REPRESENTS ECONOMY as well as PRECISION

Send stamp for complete PILOT catalog



A. C. Operation at the Cost of Batteries

For complete construction data on A. C. sets and eliminators, all designed in accordance with the latest laboratory developments, see RADIO DESIGN quarterly, edited by M. B. Sleeper.

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What is a Teletrol???

A Teletrol is a brand new radio invention. By using it in combination with his receiver, any radio fan can immediately tune to the short-wave stations. The device is simple to build; simple to operate, and can be constructed for less than the cost of a three tube receiver.

Don't fail to read about the Teletrol in the February issue of POPULAR RADIO. And don't rely too much on your local newsdealer; for POPULAR RADIO may be sold out when you get there. Better make sure of getting the magazine by sending \$3.00, which will guarantee its safe arrival for the period of one year.

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TRUPHONIC Amplification

*For the Set You Buy
For the Set You Build
For the Set You Own*

Truphonic Amplification is a new and entirely different method of audio amplification. You must hear it to realize the wonderful tone quality of Truphonic. Perhaps the following letter from the Conductor of the Springfield Symphony Orchestra will mean more to you than anything we could say.

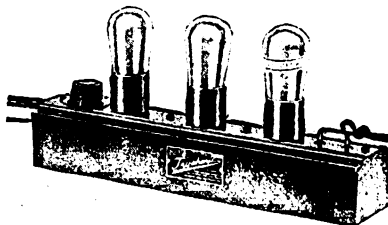
Gentlemen:—

We have given your Truphonic a good trial for a number of weeks, and will say that the clearness and distinctness of every detail in instrumentation is very much magnified. The color of the different wood-winds in the large orchestra has clearness and character which is not heard on any other instrument.

The real personality of the solo players seems to be brought out in the different instruments, especially in quality of tone.

Yours very truly,

(Signed) A. H. Turner
Conductor of the Springfield
Symphony Orchestra.

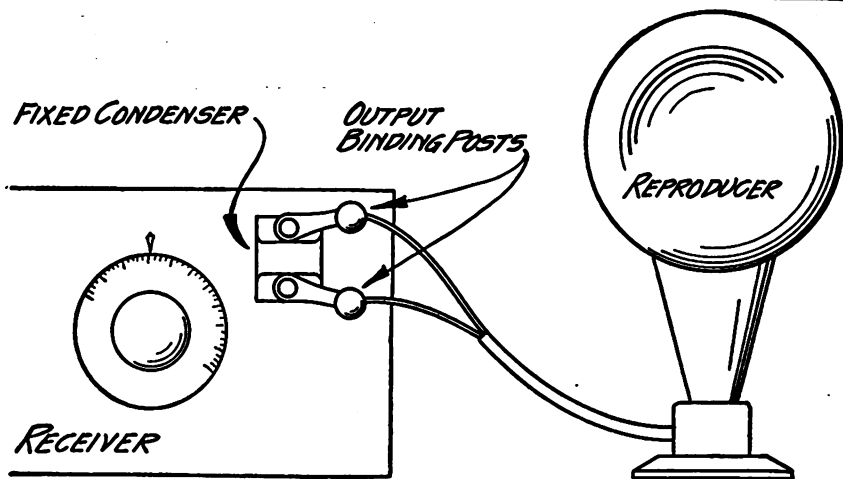


The No. 304 Truphonic Amplifier, price \$25.00, can be attached to any radio set in a few minutes. It will bring your set up-to-date, give it better quality and more volume. You cannot be convinced until you hear it. Why not see your dealer for a demonstration to-day, or order one direct.



The No. 303 Amplification set, price \$15.00, including special first stage unit to prevent motor-boating or humming, together with No. 300 Output unit, price \$5.00, is ideal for the set builder. Truphonic can be used with any set. It is easy to wire up, and can be used with battery or A. C. tubes and all power tubes. Write to-day for the Truphonic story and booklet "What to Build," Dept. T2.

ALDEN MANUFACTURING CO.
Springfield, Mass.



ONE WAY TO BETTER REPRODUCTION

FIGURE 5: A small fixed condenser connected across the output binding posts brings out the low notes with great clarity.

How to Improve the Operation of Loudspeakers

MANY types of loudspeakers and amplifying transformers give much better reproduction when small fixed condensers are connected across their terminals. With low-frequency amplifying transformers, the condenser is usually connected across the secondary winding; with a loudspeaker it is connected across the output jack in the receiving set, as shown in Figure 5. The clarity and tone of most of the older types of reproducers may be considerably improved by connecting .004 microfarad fixed receiving condensers across the speaker terminals. The addition of the condenser to the receiving set makes the music slightly weaker, but the improvement in quality more than compensates for the slight loss in volume.

—CHARLES F. FELSTEAD, 6CU, Los Angeles, California

Packing Radio Sets for Shipment

It is rather difficult to pack radio receiving or transmitting sets for shipment by express or parcel post in such a manner that they will not be damaged in transit. It is particularly difficult to ship a set that is not in a cabinet, as it is hard to support and protect the panel in order to keep it from getting broken. If perfect protection is desired, the set must be packed so tightly that there will be no danger of it jarring around inside of the packing box and becoming damaged. But if the set is packed too tightly in the box, there is always the chance that it will be crushed by the very tightness of the packing. If the set is to be shipped in its cabinet, it can be packed in a wooden box that fits closely around the cabinet on all sides except the front, where the panel is located. Layers of cloth or paper can be put between the shipping box and the sides of the cabinet to keep the latter from getting

scratched. Several small blocks of wood may be fastened to the sides of the packing case on the inside to keep the set from sliding about.

If the set has no cabinet, or is being sent merely for testing, and the inclusion of the cabinet would be an added and unnecessary shipping expense, the packing problem is more difficult. In such a case a wooden box of slightly greater dimensions than the set should be made. The bottom of the box should be of $\frac{3}{4}$ -inch or 1-inch stock. The set is placed inside of the packing box in such a position that it does not touch the sides, and several large wood screws run through the baseboard of the set into the heavy bottom of the box. Since there is space all around the set, there is no chance of it striking the sides of the box and being damaged, and thus perfect protection is provided for the panel. It is well to provide extra support for the panel in the form of wood blocks or cleats screwed to panel and baseboard.

For additional security, excelsior can be packed between the set and the walls of the packing box on all sides. In order to keep the excelsior from getting inside of the set, several layers of papers should be spread over the set before the excelsior is put into the box. If excelsior is not available, wadded newspapers may be used for the packing around the set. The tubes should be removed from the sockets before the set is packed. If they are to be shipped with the set, the best way to pack them is to replace them in their original cardboard cartons and put them in the excelsior that is packed on top of the set. Any small extra pieces of apparatus may be packed by fastening them to the inside of the back or top of the box.

The top of the box should be fastened on with wood screws, so that it can be removed easily and replaced if the set is returned in the same box. The box should be marked plainly with crayola, heavy pencil, or paint. It is best to write THIS SIDE UP on the top of the

box. The address of the party to whom the set is sent and the address of the sender must be plainly marked on the box in several places, taking care that to and from are written before the address and return address respectively. It is better that printing be used for the addresses. As an additional precaution, **HANDLE WITH CARE and RADIO EQUIPMENT—FRAGILE** should be conspicuously printed on the box. It is also wise to insure the set; for no matter how carefully the set is packed, there is always the chance that it may be damaged or lost in shipment.

—CHARLES F. FELSTEAD, 6-CU, Los Angeles, Cal.

"Keep Your Condensers Clean"

MUCH radio trouble can be traced to particles of dust getting between the condenser plates. The moral is—keep your condensers *clean*. A pipe cleaner is a very handy article for cleaning between the plates, as it is unnecessary to take the condenser apart.

—L. C. FERGUSON, Ontario, California

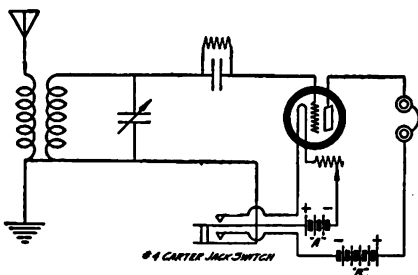
A Simple Battery Switch

A NEAT and simple switch for disconnecting the batteries in a receiving set is shown in Figure 6.

The switch that I used was a four-spring Carter jack-switch. An "on" and "off" indicator comes with this jack-switch, so a glance will tell whether the set is on or off.

As an added precaution, a small, six-volt, flashlight bulb may be connected across the filament to be operated by the switch. The bulb may be set flush with the panel in front and painted red so it will be more conspicuous. With a signal like this, there is hardly a chance of the set being left turned on at night. The use of a four-spring jack-switch is advantageous for it disconnects both the "A" and "B" batteries and there is no chance of a short-circuit ruining the batteries when the set is not in use.

—CHARLES F. FELSTEAD (6CU), Los Angeles, Cal.



THE SWITCH CONNECTIONS

FIGURE 6: The switch to disconnect both "A" and "B" batteries should be inserted in the circuit as shown here; the lamp should be placed across the filament circuit.

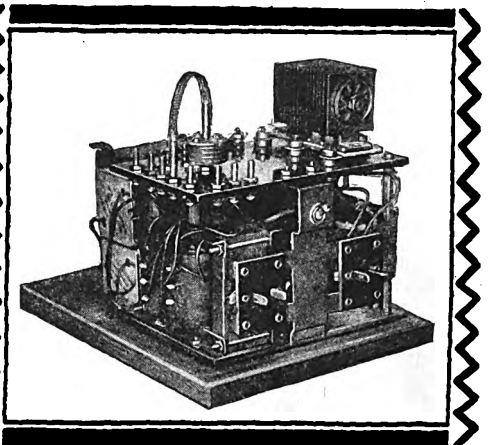
Magic Silence

the tinkle
of profits is
the only noise
in this
absolutely dry

"A" POWER UNIT
FOR

Set Builders

Knapp "A" POWER KIT



Our money making proposition for Set Builders is making the Knapp "A" Power Unit. Big Profit and Perfect Satisfaction Guaranteed.

The fundamental principle of Knapp "A" Power is entirely new and different. The absolutely dry Knapp Condenser having the amazing capacity of 1500 microfarads and condensed in a space of 2x2x8 inches is the basis of this startling new "A" power unit. No corrosive acids or alkaline solutions are used.

Absolute Quiet

Make this test; place a pair of head phones directly across the output of the Knapp "A" Power Unit—the magic silence of this perfect "A" Power Unit is at once apparent. No other "A" power unit will stand up under this test.

Perfect Rectification

The Knapp "A" Power uses a solid full wave rectifier . . . Its life is practically unlimited—in a year and a half we have never had to replace one. No tubes, no electrolytic action, no acids, alkalis, no liquids, no moving parts, a perfect rectifier.

The Knapp "A" Power supplies direct current sufficient to operate 8 tubes, one of which may be a power tube.

Assembled in a half hour

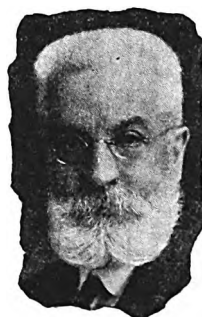
The Knapp "A" Power Kit can be assembled in from a half an hour to an hour, due to its extreme simplicity. There are only 8 soldered joints. Every part down to the last screw is supplied. And the instructions!—any one, even if they do not know a thing about radio can assemble it without difficulty. Installation consists of plugging into the light socket and connecting to set.

Special Proposition to Set Builders

Our president, David W. Knapp, has authorized us to make the set-builders of America the most amazing profit making proposition ever offered. Mr. Knapp's money making plan is open for a limited time only. Fill in and mail the coupon *today* for complete information on the finest "A" Power Unit ever designed and the most liberal discounts ever offered set builders.

5 advantages
of the
Knapp
"A" POWER KIT

1. Absolutely Dry, no acids, liquids, or tubes.
2. Perfect Rectification.
3. Magic Silence—no hum audible even with ear phones.
4. Easy to assemble — ½ hour enough.
5. Quick and easy profits with the Knapp special plan for set builders.



Knapp Electric Corporation
Port C

New Aero Circuits for Either Battery or A. C. Operation

The Improved Aero-Dyne 6, and the Aero 7—popular new circuits—are built around these marvelous coils.

You Should Learn About Them Now!

Proper constants for A. C. operation of the improved Aero-Dyne 6 and the Aero Seven have been studied out, and these excellent circuits are now adaptable to either A. C. or battery operation. A. C. blue prints are packed in foundation units. They may also be obtained by sending 25c for each direct to the factory.



AERO UNIVERSAL TUNED RADIO FREQUENCY KIT

Especially designed for the Improved Aero-Dyne 6. Kit consists of 4 twice-matched units. Adaptable to 201-A, 199, 112, and the new 240 and A. C. Tubes. Tuning range below 200 to above 550 meters.

This kit will make any circuit better in selectivity, tone and range. Will eliminate losses and give the greatest receiving efficiency.

Code No. U-16 (for .0005 Cond.)..... \$15.00
Code No. U-163 (for .00035 Cond.)..... \$15.00



AERO SEVEN TUNED RADIO FREQUENCY KIT

Especially designed for the Aero 7. Kit consists of 3 twice-matched units. Coils are wound on Bakelite skeleton forms, assuring a 95 per cent. air dielectric. Tuning range from below 200 to above 550 meters. Adaptable to 210-A, 199, 112, and the new 240 and A. C. Tubes.

Code No. U-12 (for .0005 Cond.)..... \$12.00
Code No. U-123 (for .00035 Cond.)..... \$12.00

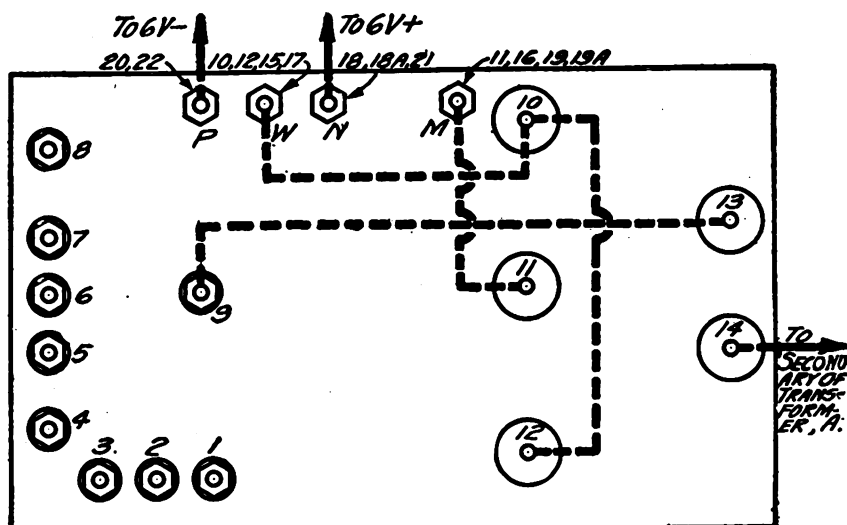
NOTE: All AERO Universal Kits for use in tuned radio frequency circuits have packed in each coil with a fixed primary, a twice-matched calibration slip showing the reading of each fixed primary AERO Universal Coil at 250 and 500 meters; all having an accurate and similar calibration. Be sure to keep these slips. They're valuable if you decide to add another R. F. Stage to your set.

SERVICE

Wish the home Foundation Circuits, house both ing with a-

"A" Power—Dry and Silent

(Continued from page 36)



THE WIRING OF THE TOP PANEL

FIGURE 4: The various terminal and studs on the top panel are referred to in the text by the numbers in this diagram. The dotted lines indicate wires that run under the panel; these must be completed before the panel is mounted.

At this point it would be well to start the screws, but not tighten them all the way down.

The builder is now ready to mount the input and output receptacle mounting. In this particular item two receptacles, one for the input of the transformer and another for the output of the rectifier, are mounted on a single metal bracket, together with a toggle switch, which is used to break the primary current of the transformer. The toggle switch, unlike the receptacle, is not supplied in place and must be attached to the plate, using the knurled lock rings supplied for this purpose. One of the switch leads is connected to the receptacle prong, B, and the other lead to the switch is connected to the input or primary side of the transformer. The other receptacle prong, Q, is connected to the other side of the transformer primary. After this operation, the switch and receptacle plate may be screwed into place with the 6/32 screws and washers intended for this purpose.

At this point the builder should mount all of the apparatus on the wooden baseboard. This should be done so that the steel base-plate carrying the transformer and choke is $\frac{3}{8}$ inch from the end of the wooden board. This permits the receptacle prongs to protrude the correct distance, when the metal shield is finally put in place after the assembly work has been completed. Directly back of the transformer and choke are mounted two special dry condensers. Metal straps are provided for these, so that the condensers can be held to the baseboard with wood screws. The relative positions of all these parts is very clearly shown in Figure 3. The condensers,

incidentally, are lettered C1 and C2 in Figure 3 and one is shown on top of the other.

When the work of mounting is completed, there is nothing left to do but to make the necessary connections, which are unusually few in number. That these connections may be made quickly and conveniently, the table below should be referred to. It shows the necessary lengths of wire used between the various points.

Lead	Sleeve
Lead from 11 to M— $3\frac{3}{4}$ ins.	$2\frac{1}{2}$ ins.
10 to W—4 ins.	$2\frac{3}{4}$ ins.
10 to 12—5 ins.	$3\frac{3}{4}$ ins.
9 to 13— $6\frac{1}{4}$ ins.	$5\frac{1}{2}$ ins.
P to 22— $11\frac{1}{8}$ ins.	$10\frac{3}{4}$ ins.
N to 21— $10\frac{1}{4}$ ins.	$9\frac{1}{8}$ ins.
14 to start of secondary, $9\frac{1}{4}$ ins. rubber-covered wire, with terminal on 14 end.	

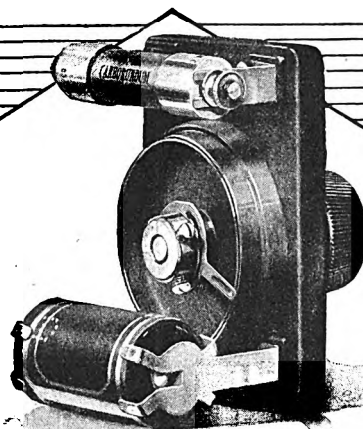
Tap No. 8 (Figures 3 and 4) of the transformer, A, is shown connected to a small resistance, T. This resistance is supplied with a pig tail and connecting sleeve which can be instantly slipped over any one of the transformer tap studs, 1, 2, 3, 4, 5, 6, 7 or 8. In Figure 3, however, it is shown connected to No. 8. The resistance, T, is also supplied with a sleeve which slips over stud No. 9, shown in Figure 4. It will be seen that this stud No. 9 is connected underneath the bakelite panel to No. 13. The opposite end of the transformer secondary (see 14a, Figure 2) is now connected to the post, 14, of the rectifier unit. This completes the connections on the rectifier unit made to the transformer, A.

Being a full-wave unit, three output terminals are supplied to the rectifier; these are numbered 10, 11 and 12. It will be noted that 10 was connected to 12 previously, and that 10 was car-

ried on over to the post, W, in Figure 4. From W the connection is carried further to the red lead of the condenser C1. This connection to the red lead is very important, since the red signifies positive and this is the positive terminal of the rectifier unit. To cross connections here would ruin the condenser. From the condenser the connection is carried to one side of the choke L1, which happens to be the choke which is mounted beside the transformer under the bakelite connection plate. These two latter connections are referred to in Figure 2 as 15 and 17. The opposite side of the choke, L1, represented by connection 18a in Figure 2, is connected to the red terminal lead of condenser C2, and thence onto the positive side of the output receptacle, which is the horizontal one and marked 21 in Figure 2.

Going back to the output of the rectifier unit, it will be noted that a lead was previously brought from M, which is the binding post on the top of the bakelite panel, to 11, which is the center tap on the output side of the rectifier unit. Reference is again made to Figure 4, which shows these two terminals connected by a dotted line. From M the connection is made to the other side of the condenser C1 and to the other side of the condenser C2, the connections being represented by 16 and 19 in Figure 2. From 19 the connection is carried to connection 19a of the choke, L2. From connection 20 in Figure 2, which is the other side of the choke, a connection is carried to the binding post, P, on the bakelite panel. From this point a connection is made to the vertical prong of the output plug, marked 22. The necessary cord and plugs are supplied both for the output and input side of the power unit. As previously stated, the rectifier unit is supplied with lugs which are clamped under the nuts of the terminals 10, 11, 12, 13 and 14 (Figure 4). With the unit in place, the metal shield may be placed over the whole unit and securely screwed to the wooden base with the wood screws supplied for this purpose. If all connections have been made properly, and these should be checked over before the unit is actually connected to the lighting circuit, the device is ready to be connected to the radio receiver. Figure 1 shows the completed job.

It will be found that some adjustment on the output voltage will be necessary, and this is done by bringing a connection from T to the proper tap of the transformer. While the output taps are marked from one to eight, it should not be assumed that this signifies the number of valves to be used. It will be found, for instance, in the case of a five-valve set, that a tap somewhere between three and six may work best, when 201-a type valves are used.



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It gives you pure, natural tones with volume. Can be used on practically any set.

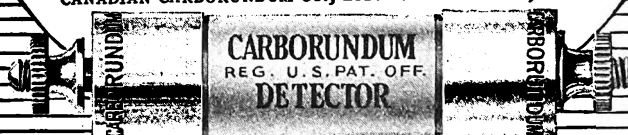
The Complete Unit for \$3.50 . The Detector Alone is \$1.50

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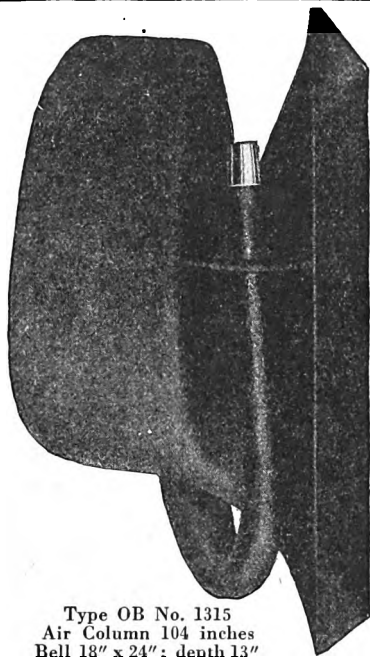
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Bell 18" x 24"; depth 13"

Racon Horns insure quality of performance much more naturally than that obtained by any other mode of amplification because of the true scientific principles of design and the exclusive material employed. Every Racon Horn conforms to the latest theory of exponential design.

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The BEGINNER IN RADIO

CONDUCTED BY ARMSTRONG PERRY

Radio Parts Salvaged From the Junk Pile

ALONG with the stuffed owl, the hornets' nest, the squirrel skins and the deer's antlers in Roy Bates' den, he had a copper tank from the wreck of a bootlegger's boat.

Some boys will sell an old tank for money to go to the movies. But Bates had a better idea: he saw in it an improved radio aerial.

He set it on four insulators, soldered a lead-in wire to it and connected it with his receiver. And it brought in WTAM, Cleveland, Ohio, and other distant stations.

Bates joined the tank with his 110-foot outdoor aerial. Pulling together, the two brought in more stations than either could alone. For still better results he improved his ground connection.

The junk pile yielded an old pail and ten feet of pipe. He cut a hole for the pipe in the bottom of the pail and

punched others in the bottom and sides with a hammer and a spike. He dug a pit in the cellar and sunk the pail in it. Through the pail he drove the pipe down eight feet. He attached his ground wire to this and to a water pipe; two grounds halve the resistance. Filled with water, the pail automatically kept the ground wet and the connection good.

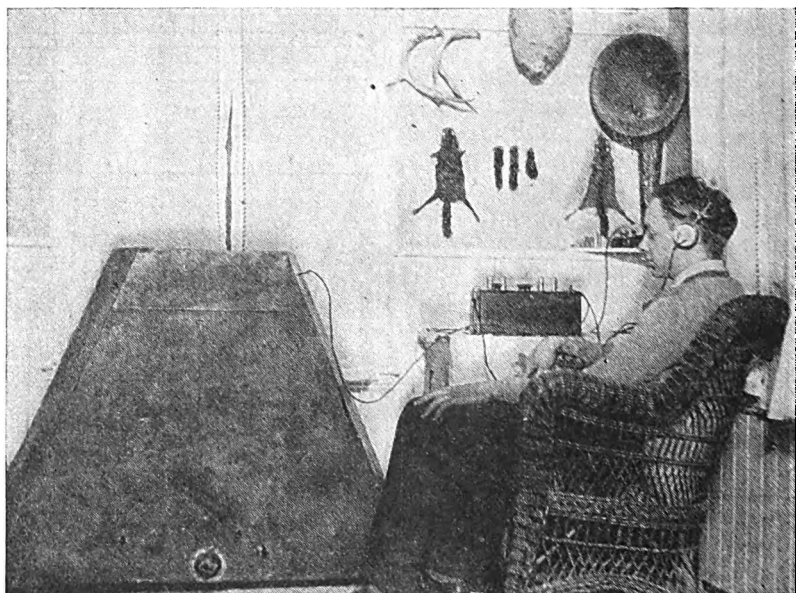
The wintry wind howled its defiance; there was a thrill in sitting in his cozy den, bringing in the far-off voices.

"This is WMBF," said an announcer. Miami Beach, Florida! That was reaching out!

The man at the mike announced an intermission. "It is very warm here—we are all going to have some ice-cream," he said.

Ice-cream! Bates looked at his frost-covered thermometer outside. Fourteen below zero! He smiled:

"Anyhow, I have proved that there is a lot of junk that is good for something in the radio game."



MUSIC FROM THE OLD DISTILLERY

With this old copper tank salvaged from the wreck of a bootlegger's boat, Roy Bates improvised an antenna that brought in broadcasters from across the continent.

"Murdering" the Vacuum Valves

MANY beginners find their valves dead several months before they should be. Usually they have been "murdered." Too high voltages have been applied to the filaments.

Some receivers have meters to show when the filament current has the correct voltage, but more have none. Operators usually judge by the brightness of the filament, or by the sound; both of these methods are inaccurate.

Men who temper steel can judge its temperature by its color, but that takes years of experience. Even highly trained vision cannot tell by the glow of a filament whether it is receiving the proper voltage or not. Sound is equally unreliable, for atmospheric conditions change the volume.

Beginners sometimes crowd the filament because increase of voltage usually increases the sound and seems to promise better results. Reducing the voltage suggests loss of power to a beginner, although, in fact, it often is the only thing that will bring in the broadcast clearly. Even the ear sometimes becomes an accessory to the murder of the valve, because after hearing loud sounds, lower ones of great clarity and beauty may seem weak.

After a filament is damaged by too high voltages, it may be unable to emit enough electrons without excessive voltage. It is then a sick filament and will die an untimely death. The thousand hours or more of service that it might have given if used properly may be reduced by more than half.

Most valves used in receivers do not need to burn brightly, as they are not intended for use as electric lights. They may operate efficiently at such low temperatures that the glow cannot be seen in daylight unless a deep shadow is thrown on the filament.

The way to make a valve give the best results for the longest time is to give it the minimum current that will produce clear tones. Those who cannot be happy without making a loud noise will find it cheaper to turn off the juice in the radio set and use a horn operated by hot air.

* *

Rheostat Regulates Loudspeaker Volume

S. R. HIPPLE, a radio inventor of Williamsport, Pennsylvania, reports that a filkostat, or pressure type rheostat, inserted in the circuit between the "B" battery and the plate of the last amplifier valve will control the volume of the loudspeaker. Other types of rheostats might be employed, but only those wire rheostats that have vernier attachments give as smooth and continuous adjustments as a good rheostat of the pressure type.



When you buy a new Radio Set or refit an old one—insist upon

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A type for every radio need.

Your dealer will help you select the types needed for your set

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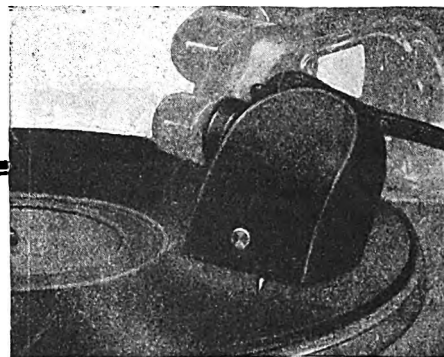
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ATTACH the Pacent PHONOVOX to your radio and phonograph! Play one of your favorite records! The wonderful tone quality of reproduction; the greater volume will amaze and delight you—giving you at the small cost of \$12.50 the superb reproduction equivalent to the costly electric phonograph.

And the PHONOVOX is so easily

and quickly attached to your radio and phonograph without tools or making any changes in wiring. There are no adjustments to make—nothing to wear out or get out of order—and it will last indefinitely. All good radio and phonograph dealers handle the PHONOVOX. Ask for it by name and accept no substitute.

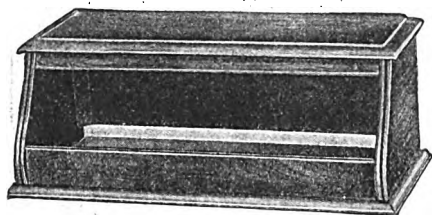
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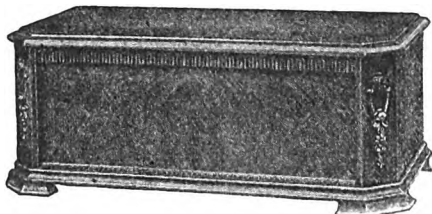


Model LC-28 Walnut \$18.00



Model LC-28-D-20 Walnut
\$70.00

The authorized cabinets for the LC-28. Made to take the aluminum 6x26-inch panel, with 25 degree slope.



Model "C" Walnut

The ultimate in elaborate and attractive radio cabinets is offered in our model "C." It is an adaptation of the old Italian Chests, being designed and decorated after the spirit of the Renaissance period.

Grooved for 3/16-inch panel with removable top rail. Fancy top stay and piano hinge are applied.

PRICE LIST MODEL "C" CABINETS

Panel Size	Walnut Only		Weight	Mounting Boards
	10 in.	12 in.		
7x18	15.50	17.00	26	.90
7x21	17.00	18.50	28	1.00
7x24	19.00	20.50	31	1.10
7x26	20.50	22.00	34	1.20
7x28		23.00	37	1.30
7x30		24.00	40	1.40

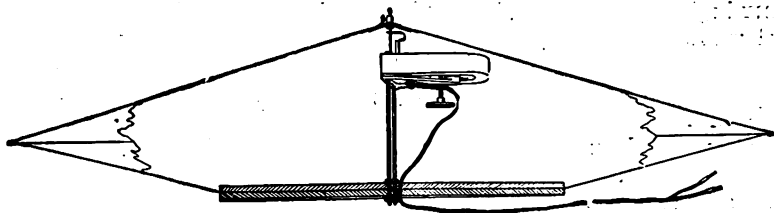
Corbett cabinets are in stock ready for shipment.

Write for illustrated folders.

CORBETT CABINET MFG. CO.
ST. MARYS, PENNA.

3-Foot Double Cone Speaker

(Continued from page 45)



A CROSS-SECTION OF THE COMPLETED UNIT
FIGURE 4: In this cut-away diagram of the cone the method of attaching the driving unit is clearly shown.

force the apex of the big cone. This is cut along the solid line, smeared with cement to the edge of the segment and held in shape until it dries, thereby forming a tiny cone which will later be fitted snugly inside the front cone.

This particular speaker is supplied with an extra-heavy back ring, which is cut out of very heavy, durable board of special composition. The cement is poured on one side of the back ring and spread freely over the outer ring. Care should be taken to see that none of the cement gets on the cross-arm. The back ring is now ready to place on the back cone at the points indicated on the prepared paper. Heavy weights should be applied and sufficient time allowed to insure adequate drying.

Now apply the binding braid to the outer edge of the cone, making sure that it folds over the outer edge in such a manner that half of it is bound to the front cone and half to the back. A few clothes-pins will help in holding the braid until it is dry.

Next, the builder must fasten the back ring latch to the back with a nail or scribe, or some other sharp-pointed instrument. Reference to Figure 3 will assist the builder in visualizing this important step.

The builder now takes the adhesive fabric which is supplied and cuts off a strip about 18 inches long. From the part of the fabric that is left the builder should cut as many 1/4-inch strips as possible. The cone is then held as shown in Figure 3, and the latch closed, making sure that the tongue slides into the groove. The cone should adjust itself, conforming perfectly to the proper shape. If it should fail to do this, due to some slight inaccuracy, the constructor should carefully bring it into shape with his hands.

It will be noted that the edges of the wedge-shaped piece, which were cut from the front cone in an earlier part of the construction, come to a butt joint. Lay the cone on a smooth, hard surface with the slit down, as shown in Figure 3. Work should be done on the inside, with the edges of the slit tight up against one another. They should be held down tightly with one hand while the other hand is used to glue the 1/4-inch strips, which had been

previously cut from the adhesive fabric, across the slit.

Now the builder is ready to examine the job. If that is right, the 18-inch strip of adhesive fabric is dampened and run from the apex of the cone to the edge on the inside of the cone.

The little reinforcing cone which was previously cut out and cemented together should now be spread with cement and fastened onto the inside of the apex of the front cone. With a sharp instrument punch a hole in the exact apex, working from the inside of the cone out.

There is now nothing left to do but assemble the driving unit which is supplied. First thread the smaller of the two conical discs on the chuck. The chuck should be run from the outside through the hole at the apex of the front cone, and the larger of the two discs threaded on the chuck inside the front cone. A nut is run under the thread and fastened securely. Figure 4 shows the position of the parts.

The builder must now take steps to fasten the cross-arm to the back ring securely by means of the nuts, bolts and washers supplied.

Onto the long thread at one end of each of the two unit mountings place a nut, and run it all the way up the thread. Slide a washer against it. Working from the inside, run the remainder of the long thread through the holes in the back ring which are on each side of the center hole. Still another washer should be placed on each of the unit mountings, together with a nut which is run up so that the nut is flush with the end of the unit mounting. The special cone speaker unit may then be put in place, holding the speaker with one hand with the apex pointing straight down. The driving rod or stylus should be carefully guided so that it will thread into the chuck. And here the builder must be careful not to bend the driving rod or to puncture the cone.

The remainder of the parts involved in bringing the cone to a workable condition are so simple that it is not necessary to describe them fully. The mounting of the accessories that come with the kit is accomplished in a short time, and the unit is ready to be hooked up to the receiver output.

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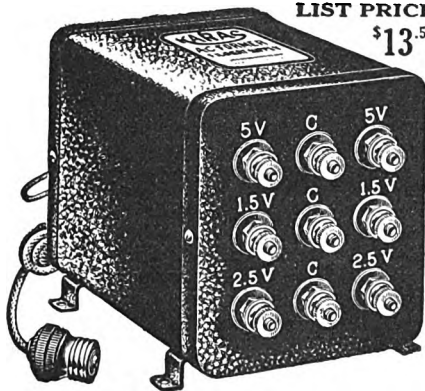
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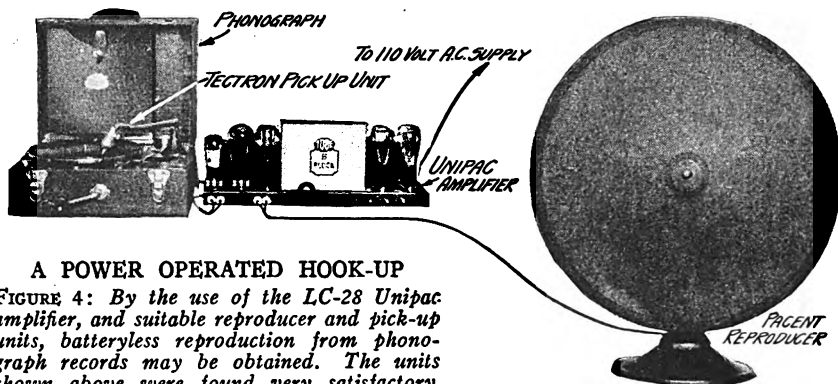
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"Radioize" Your Phonograph

(Continued from page 46)



A POWER OPERATED HOOK-UP

FIGURE 4: By the use of the LC-28 Unipac amplifier, and suitable reproducer and pick-up units, batteryless reproduction from phonograph records may be obtained. The units shown above were found very satisfactory.

frequency amplifier, just described, is connected with "B" and "C" batteries and with an Abox "A" eliminator, that replaces the ordinary storage battery, and with a Racon exponential type reproducer, equipped with a Baldwin unit. This combination, in which each part properly co-ordinates with every other part, gives exceptionally fine tone results with the new electric-cut phonograph records.

A Zetka ZAF vacuum valve has been found to operate best in socket D1, and a Zetka ZAO type vacuum valve works best in socket D2 of the low-frequency amplifier. These are new type valves especially designed for quality reproduction.

In setting up this combination, the "A" eliminator and the "B" battery, as well as the low-frequency amplifier, may be placed in a portion of the phonograph cabinet with the Racon reproducer, connected by a Belden extension cord, on the other side of the room. The old sound box on the phonograph is not used, and this space is, therefore, made available for most of this apparatus.

This combination is suitable for ordinary home reception and will give plenty of volume for this use—many times more than the old-style phonograph, with a beautiful tone quality.

The Second Combination

Another combination that is totally power operated from the 110-volt, 60-cycle AC lighting lines, is shown in the pictorial hook-up in Figure 4. The nucleus of this unit is the LC-28 Uni-

pac amplifier, the details of construction of which were given in the November, 1927, issue of POPULAR RADIO. This amplifier, as said before, is completely power operated, and when connected, as shown in Figure 4, to an electric pick-up unit and a suitable reproducer, will give exceptionally high volume with excellent tone quality. It needs no external batteries of any kind for its operation, as it uses one 227 type amplifier valve in the first stage and a 210 type amplifier valve in the second stage. There is also included in the Unipac an 874 voltage-regulator valve and two 216-b rectifier valves. An extension cord is fitted to the unit for plugging into the lighting lines whenever the phonograph is to be used.

This combination is satisfactory where exceptionally large volume is desired. With this combination the new electric-cut records reproduce with such startling quality that the listener is almost led to believe the song or music is being executed for the first time, while it is being played. The reproduction sounds like the original.

The complete installation on either of these two units can be done in less than fifteen minutes, once the low-frequency amplifier is constructed.

A phonograph so improved will compare favorably with the latest type of electrically operated commercial phonographs, as it will then contain substantially the same type of apparatus. And while a completely new phonograph would cost many hundreds of dollars, either one of these units can be installed at comparatively low cost.

"This Is Europe Speaking"

Or maybe it's Australia or Africa. All these countries will be in the receiving range of your old receiver, if you plug in the Teletrol wavelifter that adapts any receiver to the magic world of short-wave reception. Don't fail to get the complete constructional details of this marvelous new device in the February issue of POPULAR RADIO.

The New Home Receiver

(Continued from page 33)

Home receiver is quickly neutralized within the set, and once this adjustment is made the drums may be tuned over the entire waveband without a circuit howl or whistle.

How to Assemble the Instruments

The first job is to mount the condensers, D, E and F, against the flat surfaces of the brass frames. The drums are then slipped over the shafts of the condensers until the worm gears mesh with the flanges of the drums. As these condensers are to be mounted facing in opposite directions, it will be necessary to substitute, on one of the drums, the extra worm gear that is supplied with the frame, and also to transfer the knob shaft which holds the gear from the top to the bottom of the frame. When completely assembled, the units should be affixed to the panel, Z. The rheostat-switch, S, should then be fastened to the panel with the switch terminals pointing to the baseboard, Y. This will complete the panel assembly and it should be laid aside until the wiring of the instruments on the baseboard has been completed.

Next prepare the small binding-post strip, X, and mount the two binding posts, V1 and V2, and the pup jacks, U1 and U2.

Before screwing the various parts on to the baseboard, each part should be carefully examined and tested for any faults. This can be quickly done with a small "C" battery and headphones. The location of the parts is so clearly shown in Figures 1 and 2 that a further detailed description is hardly necessary. Follow the diagram in mounting all of the parts on the baseboard.

How to Wire the Set

If the instructions given for wiring in Figure 2 are carefully followed out, no trouble should be experienced. A hot, well-tinned iron is absolutely necessary for a permanent job, and extreme care is advised in the bending and fitting of the various leads to assure a neat and efficient appearance in the finished job. Make absolutely sure of each connection before proceeding to the next and remember that this part of the construction is to "make or break" your finished set.

Constant reference should be made to Figures 1 and 2. Black celatsite bus bar is recommended for connections to give the set a finished appearance. All references as to "right" or "left" should be considered when facing the baseboard with the back edge of the set nearest the builder.

Starting at the cable connector plug, W, the "A" positive (+) lead should be run along the baseboard to within 1 inch of the front edge and thence

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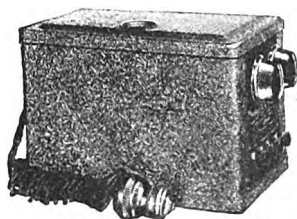
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PR-1

over to a point where it will eventually be soldered to one terminal of the switch, S. To determine this point, the panel should be held temporarily in position against the baseboard, and the wire fitted for future connection. From the remaining terminal on switch S run a wire to one outside terminal of the potentiometer, K. This wire should be looped slightly from the base directly in front of the left filament post of socket J2, and a connection made between these points. From the socket the wire should continue between instruments J3 and H2 and connected to a wire connecting the two right-hand terminals of sockets J3 and J4.

Now connect the "A" negative (—) and "B" negative (—) posts of plug W together and run a wire from here to the right lug on amperite O. To this same wire connect the ground binding post and one terminal of the rotating winding (white wire) of coil A, and the left-hand bottom terminal of the secondary winding (enamel wire) terminal of the same coil. Also, from this same wire, run a lead along the base between the impedance units and coils, and connect this wire to the front terminal of amperite P. From this wire make connections to the "F" negative (—) terminal of impedance H1, and also to the "F" negative (—) and "B" positive (+) terminals of transformer G, and thence to the remaining outer lug of potentiometer K.

From the "B" Det. terminal of the cable plug, W, run a wire to the center terminal of the primary of coil B, and make a connection from this lead to the nearer terminal of condenser Q1. From the "B" Amp. post of W run a wire along the extreme back edge of base to the "B" positive (+) lug on unit H1. From the green terminal of the plug, W, run a wire, beside the one just fastened, to the "F" negative (—) lug of impedance H2; and beside this lead run a wire from the brown post of W to the "B" positive (+) terminal of choke I.

Now connect the remaining terminal of amperite P to the two remaining filament posts of sockets J3 and J4; and from this lead make a connection to the remaining filament post on socket J2. Run a wire from the antenna post to the remaining terminal on the rotating winding in the center of coil A. The two terminals of the rotating winding are at the top right of the large cylinder, as shown in the picture wiring diagram in Figure 2. The green winding is left unused. This will complete the long leads, all of which are run along the base, and we have but the short leads between the instruments to wire.

Beginning with the output filter condenser, Q2, connect one terminal to one of the pin jacks, U, and connect the other terminal of Q2 to the S1 lug of

choke I. Connect the remaining jack to the "A" negative (—) to ground wire. Connections should now be made between the following points: P lug of choke I to plate post of socket J4, and from grid post of this socket to G lug of impedance H2; from P lug of this unit to plate of socket J3, wire from grid of this socket to G lug of impedance H1.

Now connect the left-hand terminal of primary of coil C to the P terminal of impedance H1. Connect the condenser, R, between this lead and the "A" negative (—) lead to amperite P beneath. Connect the remaining terminal of primary of coil C to plate of socket J2. From the grid of this socket run a wire to the front secondary terminal of coil B. From the remaining secondary terminal of the same coil run a lead to the G lug of transformer G. Connect one outside terminal of the primary of this same coil to the plate post of socket J1. The remaining primary terminal should connect to the left lug of condenser M. The other lug of this condenser should be connected to the grid post of socket J1, and thence to the right-hand bottom terminal of the enameled wire winding of coil A. The right-hand filament post of this socket should be connected to the remaining terminal of amperite O. The remaining lug of condenser Q connects to this same lead.

The panel should now be screwed to the baseboard for the completion of the wiring. First solder the two leads to the terminals of switch S. Connect the two extreme outer terminals (these point upward) of the dial lights, and run a wire from this connection to the left terminal of rheostat S. Also make a connection from this wire, just placed, to the set side of the "A" positive (+) lead. The right terminal of the rheostat should now be connected to the remaining filament post of socket J1.

Connect together the two long lugs of the dial lights (these lugs run parallel to the baseboard), and from this wire run another wire to the terminal nearest the panel of condenser D, and from there to the battery side of amperite O. The remaining post of this condenser should be connected to the grid lead of socket J1.

The four terminals of condensers E and F should now be connected to the proper coil leads. Starting with those terminals nearest the panel, the right-hand one, or that nearest the drum, should connect to the lead between the G terminal of transformer G and coil B. The other should connect with the left secondary terminal of coil C, and a connection made between this lead and the middle post of potentiometer K. Place condenser T between this lead, just run, and the "A" negative (—) lead to the potentiometer.

On the rear side of condensers E

and F the terminal nearest the drum should connect to the wire leading from coil B to grid of socket J2. The remaining terminal should be connected to the remaining secondary terminal of coil C, and this wire should be looped to take care of the G end of the crystal L, the "A" end of which should be placed in a small bus loop, which is soldered to the P terminal of transformer G. The arm of potentiometer K should now be swung entirely to the "A" negative (—) side, and we are ready to hook up the set to the proper power source and put it in operation.

How to Operate the Receiver

The batteries should now be connected to the cable as shown in Figure 4, and the plug connected to the set. Three 201-a valves should now be placed in sockets J1, J2 and J3, and a 171 valve placed in socket J4. The antenna and ground leads are next connected to their respective posts, and the loudspeaker connected to the pin jacks.

After tuning in a signal, the rheostat should be turned back to the lowest audible volume and the small compensating condensers on the double condenser, E and F, adjusted to maximum resonance. In this operation both condensers should be turned counter-clockwise to cut as much of this extra capacity from their circuits as possible, yet still keeping the circuits in resonance.

It will then be necessary to tune in a station of a low wavelength, and adjust the neutralizing condenser, M, to that point where no squeals will be heard when tuning. If such a point cannot be found, it will be necessary to reverse the two outer primary connections of coil B, which accordingly changes the phase of the high-frequency current flowing to the grid of the second valve. The arm of potentiometer K should now be advanced slightly to maximum signal response, always keeping this adjustment on the negative side of the instrument.

The new receiver will be a revelation in quality reproduction and should be of exceptional interest to those who prefer the crystal detector with the added amplification of vacuum valves acting as high-frequency and low-frequency amplifiers. Furthermore, if the receiver has been properly built and wired, its upkeep, both in time and money, will be considerably less than that of sets which employ a greater number of valves.

It will be found that the receiver will operate very economically with "B" batteries, as shown in Figure 4. If it is desired to use a power-pack to furnish the "B" voltages, it is quite easy to construct one that will deliver full voltage at the light load which this receiver places upon it.

ELECTRIFY WITH THE NEW A.C. TUBES

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Directions are packed with each adapter, and standard harnesses are made for the following sets:

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If you wish to make your own harness, the standard equipment for tuned radio-frequency sets that are wired for a power tube is:

1 No. 924 GT Connectorald, with 1,000-ohm Y tap resistance for the power-tube stage.
1 No. 924 GT Connectorald, with 500-ohm Y tap resistance and two Midget by-pass condensers for the first audio stage.

1 No. 927 Connectorald for the five-prong detector tube.

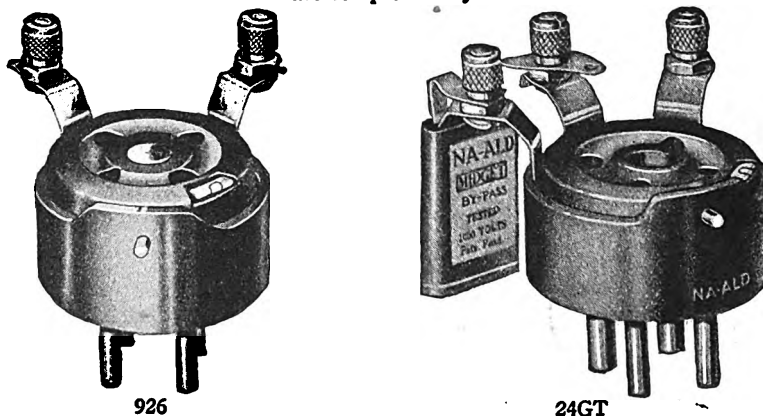
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(See other pages of this magazine for particulars of Na-ald, new A.C. sockets.)

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In every village, town, hamlet and city in the United States readers of POPULAR RADIO are capitalizing their knowledge of the art and are making money quickly and easily. You, too, can build up spare time income in servicing or building radio receivers. In the February number of POPULAR RADIO, Charles A. Kennedy of Albany, Indiana, tells how he makes \$1200 a year in spare time, following his fascinating hobby of radio.

At the present time there are 50,000 professional set-builders in the United States and, by the end of 1928, there will be 75,000. Are you going to be one of them? Are you going to make money out of your fun?

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Ease, Economy and Accuracy in Construction

Simplified Blueprints make it possible for anyone, without previous knowledge of radio, to construct a highly efficient radio receiver. These Blueprints consist of 3 diagrams as follows:

Panel Pattern

This Blueprint is the EXACT size of the actual set. So accurate that you need merely lay it on your panel and drill as indicated. No scaling or measuring to do, no danger of ruining the panel through faulty calculation.

Instrument Layout

Here again you have an actual size print of each instrument and binding post and its exact location both on the panel and within the cabinet.

Wiring Diagram

The unusual feature of this Blueprint is that it is an actual size picture diagram of the finished set. Each instrument and other parts appear in exact size and the wires are so clearly traced from one contact to another that you can connect all terminals accurately without even knowing how to read a hook-up diagram.

Set No. 18—"The Improved Raytheon Power-Pack" (as described in the May, 1926, issue of POPULAR RADIO).
Set No. 22—"The LC-27 Broadcast Receiver" (as described in the October, 1926, issue of POPULAR RADIO).
Set No. 23—"The LC-Senior Power-Pack" (as described in the November, 1926, issue of POPULAR RADIO).
Set No. 24—"The LC-Intermediate Power-Pack" (as described in the December, 1926, issue of POPULAR RADIO).
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BROADCASTS

Telling Fortunes by Radio

A NOVEL "radio game" that requires only a radio receiver for its equipment has recently been originated—if newspaper reports are to be credited—by Dr. Edwin E. Slosson of Washington, D. C. How fortunes may be told by this novel game is described as follows:

In order to play the game, select a person who wishes to have his fortune told. Blindfold him, direct him to the radio set, and have him tune in a station. Whatever comes in first is supposed to be applicable to the one who tuned in. No matter whether music or words are received, it is seldom that some significance cannot be attached to what is heard.

Dr. Slosson was entertaining friends the other night. He proposed his game. Most of his guests, scientific and dignified, were intrigued with the idea. Dr. Slosson was elected to have his fortune told first. So he went to the set and tuned in.

"Many people have lice without suspecting it," said a voice from out of the nowhere.

Red of face, Dr. Slosson turned the set off.

Next an elderly lady tried her luck. After being shown, she tuned in a station.

"Suppressed desires frequently are responsible for your unnatural actions," said a voice from some unknown station.

They abandoned the game.

A Radio Scarecrow

RADIO has been introduced as the newest farm implement by Gustav Schmitz, owner of a huge orchard near Hornburg, in Germany. Despairing of saving his valuable harvest of apples and pears from the clouds of voracious sparrows unmoved by ordinary scarecrows, he installed a loudspeaker in the orchard and at the announcer's first words the winged pests fled, terrorized, never to return.

Radio Resuscitates the Furniture Business

WHEN the automobile and the moving picture started taking men from the parlor and the fireside, the furniture business took quite a flop. But now, says Harry C. Sorden, Secretary of the National Association of Upholstered Furniture Manufacturers, radio is bringing the family back home to enjoy broadcast programs, and home furniture is again finding its place in

the sun. Of the \$900,000,000 spent for furniture sold last year, a third was put into furnishings for the parlor and living-room, large armchairs being in particular demand.

* *

Radio Demonstrates Its Reach

A SPECTACULAR demonstration of radio's marvelous powers in bringing together all parts of the world was given recently when A. M. Morton, of the Radio Corporation of America, directed an almost instantaneous interchange of messages between himself, at the Pennsylvania Hotel in New York, and several foreign countries and sixty-seven ships at sea. The demonstration was given before the Export Managers' Club, as an example of what radio has accomplished for international communication. Within three minutes of a broadcast call for positions of ships at sea, messages started pouring in from ships in the North Atlantic and the North and South Pacific. Then a broadcast request for weather reports brought replies from such widely separated places as Honolulu, Paris, Buenos Ayres, Berlin and Bogota—all within another three minutes' time.

* *

United States Has Over Half of World's Broadcasters

MORE than three-fifths of the broadcasting stations in the world are located in the United States, according to the figures of the electrical division of the Department of Commerce. The 1,116 broadcasting stations of the world are distributed as follows: United States, 685; Europe, 196; North America, outside of the United States, 128; South America, 52; Oceania, 28; Asia, 18; Africa, 9.

Division of stations by countries gives the following order: Canada, 59; Cuba, 47; Sweden, 30; Russia, 28; Australia and Germany, 24 each; Argentina, 22; United Kingdom, 20; France and Mexico, 18 each; Spain, 15; Brazil, 12.

The most powerful broadcasting stations, outside the United States, are those at Motala, Sweden, and Moscow, Russia, broadcasting with 40,000 watts.

Transoceanic Calls Heard

POPULAR RADIO's "Calls Heard" Department is ready to serve all American amateurs by forwarding their calls heard (QSL) cards to their proper destination in foreign countries. These cards are delivered through agents in those countries who have or can obtain knowledge of the present address of foreign amateurs. POPULAR RADIO is also doing the foreign amateur the service of forwarding his QSL cards to the proper destination in this country. In addition, the magazine will publish a monthly list in the "Transoceanic Calls Heard" column. Address your cards to the foreign amateurs by call number and enclose them in envelopes to—

The Calls Heard Editor
POPULAR RADIO

119 West 57th Street, New York

E. J. F. SAMPSON, operator of amateur station NU-1DI, Brockton, Mass., reports the reception of the following European stations, using a low-loss receiver with one stage of low frequency: EB-4WW, EF-8CL, EF-8EO (fb.), EF-8FK, EF-8IX, EF-8JF, EG-6YQ, EI-1DM, EI-1ER.

STATION EF-8CC, operated by M. Suquet, Chatillon-sur-Seine, France, reports the reception of the following stations in the United States, using a Schnell circuit with detector and one stage of low frequency:

1AGT, 1BHM, 1CAR, 1MV, 1SZ, 2AZK, 2BAD, 2HC, 3AHL, 3MB, 3SH, 4SN, 8BPL, 8CXH.

AMATEUR station EF-8IX, operated by R. Simon, Choisy-le-Roi (Seine), France, reports the reception of the following stations in the United States, using a Schnell circuit with detector and one stage of low frequency:

1ASU, 1BAT, 1BYV, 1CMX, 1CNZ, 2BOW, 3LD, 7VH, 9DR.

J.-L. MÈNARS, the operator of amateur station EF-8FJ, Longchamp-Bordes (B.-P.), France, reports the reception of the following United States stations:

1AKM, 1BKC, 1CAW, 1CMX, 1KD, 1XV, 2HC, 4AK, 5KC, 8BGO, 8DKX, 9DNG.

The amateur station of R. Huchet (EF-8DDH), Nantes, France, reports the reception of the following stations in the United States:

1ALS, 1BDW, 1CK, 1CMF, 1DL, 1ID, 1MR, 2AYJ, 3BCO, 3BUW, 3ZM, 4AAH, 4SI, 8BUN, 9AEB.

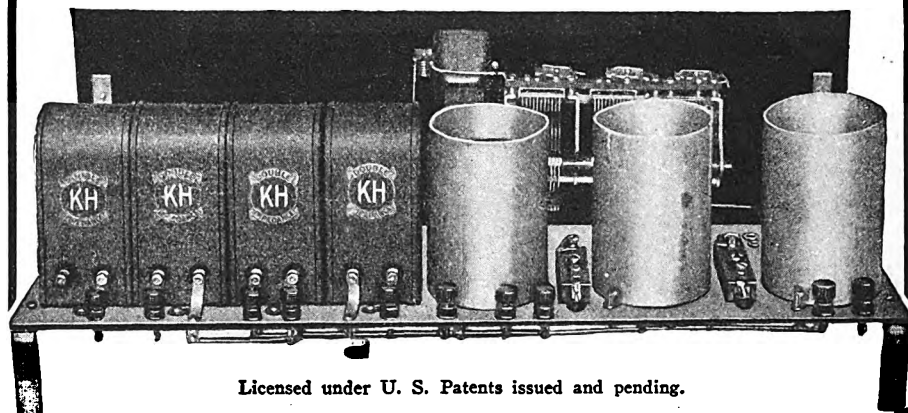
AMATEUR station EF-8AKL, France, reports the reception of the following stations in the United States, using a Bourne circuit with detector and two stages of low frequency:

1AKM, 1ATG, 1BFX, 2BEM, 3GF, 3JN, 3LD.

LUCIEN BENSIMON, operator of amateur station FM-8MB, Casablanca, Morocco, reports the reception of the following stations in the United States, using a detector and one stage of low frequency:

1DI, 3AHL, 6AM, 6HU, 6KBC, 8BZU.

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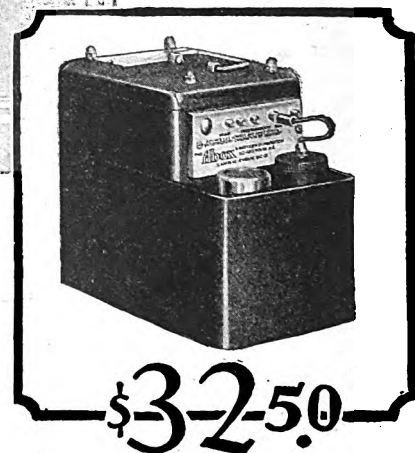
KENNETH HARKNESS, Inc.

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Abox

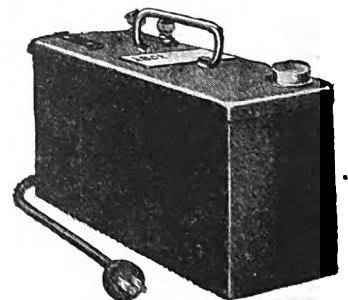
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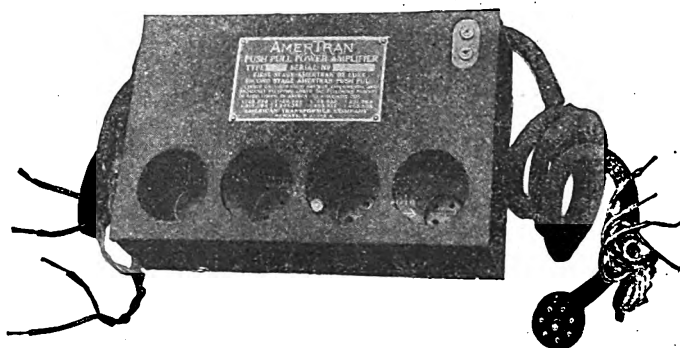
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Popular Radio

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VOLUME XIII

February, 1928

NUMBER 2

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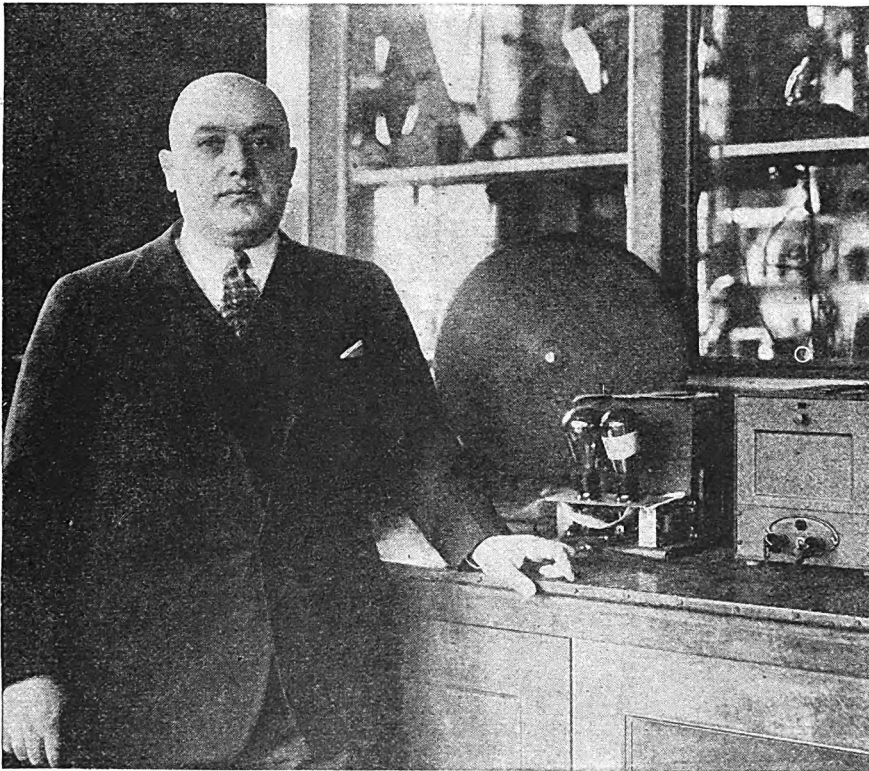
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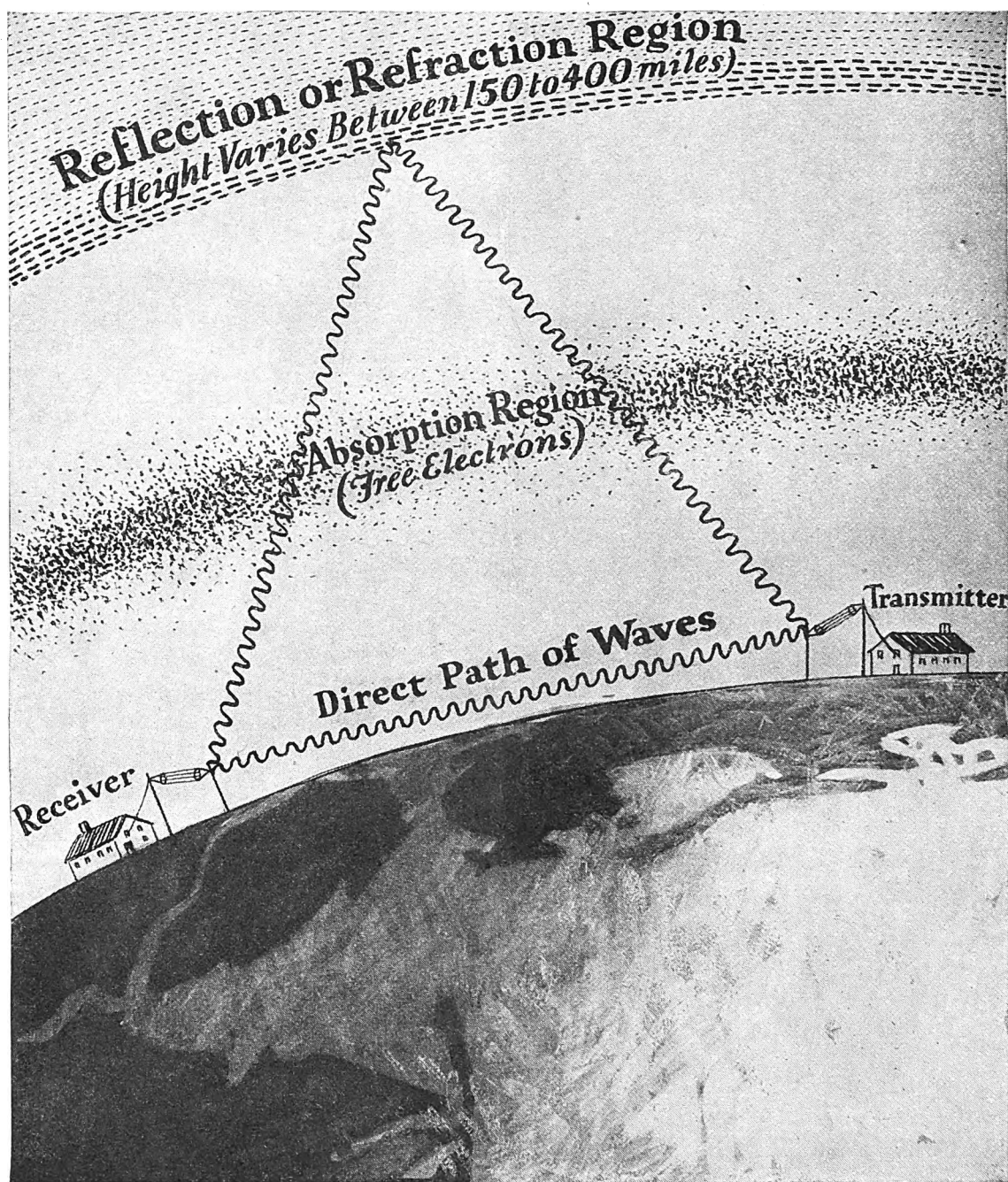
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As the inventor of several radio devices and a recognized authority on radio engineering, his predictions in radio may be taken by experimenters as endorsement from one well qualified to pass judgment in radio matters.

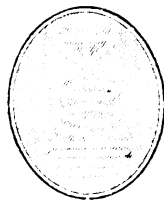


From a drawing made for POPULAR RADIO by A. G. Hagstrom

How Waves Are Reflected From the Radio Roof

A series of penetrating experiments proved in the past that radio waves, in passing from the transmitter to the receiver, travel over two such paths as are shown above. One is direct and the other is pyramidal, passing from the transmitter to a reflecting or refracting medium in the upper regions of the atmosphere, and thence to the receiver. Obviously these waves, having a longer distance to travel, will reach the receiver an infinitesimal fraction of a second later than those received along the direct path. By a careful calculation of the difference in time between incoming signals, science has found the approximate location of the region of reflection. Mr. Raymond A. Heising, whose article on the opposite page incorporates the latest discoveries about the nature of this region, deduces from his experiments that the reflecting layer rises and falls very rapidly at times, with the consequence that the amount of reflection, and hence the volume of received signals, varies. It is this action that we experience in the phenomenon of fading. Mr. Heising's experiments also lead to the belief that there is, between the earth and the reflecting region, another atmospheric layer where free electrons that are present from solar radiation absorb a considerable portion of radio energy, so that weaker high-frequency radiation will not survive the journey.

Popular Radio



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IS FADING CAUSED BY THE MOTION OF The Earth's "Radio Roof?"

It has been generally known for some years past that radio waves are practically earthbound. Their terrestrial imprisonment is brought about by the existence in the upper and less ponderable regions of the earth's atmosphere of a stratum of gas molecules that acts as a reflector of radio waves. In this article Raymond A. Heising, who is one of America's greatest research engineers, describes a series of experiments that would seem to indicate that fading, the bugaboo of broadcast reception, is caused by the rising and falling of this layer.

RAYMOND A. HEISING

Research Department, Bell Telephone Laboratories, Inc.

WITH the first transmission of radio signals across the Atlantic, a phenomenon was demonstrated which previously had been considered impossible. Electromagnetic waves of all kinds are believed to travel in straight lines unless deviated by some unusual condition, and so it had been considered impossible to transmit radio signals over long distances, because of the curvature of the earth. Success of the transatlantic transmission showed, however, that unless there were other elements entering into the transmission conditions than those previously considered, the theory of straight-line travel was wrong. Attempts were made to account for success of the transmission on the basis of atmospheric refraction, dispersion, and the effect of a conducting ground, but none of these explanations was entirely satisfactory. In the meantime it was suggested that the cause might be reflection from an ionized region in the earth's atmosphere.

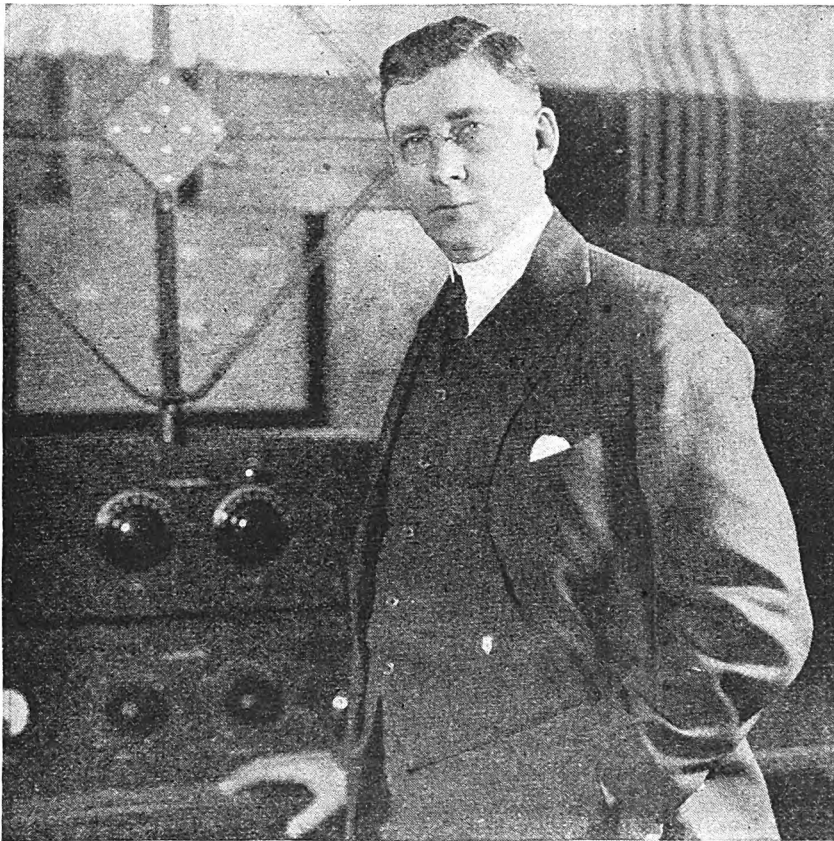
When a wave enters a medium in which its velocity of propagation varies from point to point, its direction of advance becomes curved. If the change in velocity is rapid enough, the curvature is so abrupt that the effect is much the same as that of reflection from the surface of the medium. It is often convenient to speak of this phenomenon as reflection, although it is really one of refraction. How radio waves are supposed to be bent was shown graphically on pages 349-353 of the BELL RECORD for June, 1927.*

This suggestion was made over twenty

* Further information on the Heaviside region of the atmosphere may be obtained from the following articles that have appeared in POPULAR RADIO: "A New Theory of Fading Signals," by Dr. E. E. Free, p. 409, October, 1924; "New Ideas of the Heaviside Layer," by Dr. E. E. Free, pp. 85-6, July, 1925; "The Up and Down Movement of the Heaviside Layer," by Dr. E. E. Free, pp. 61-3, January, 1926; "Why Signals Fade," by Charles C. Bidwell, pp. 531-8, October, 1926; "Three Blankets Around the Earth," by Dr. E. E. Free, pp. 327-30, April, 1927; "The Radio Ceiling," by Uthai Vincent Wilcox, pp. 552-3, June, 1927.

years ago, but it is within the last few years that the ionized zone has been shown as the real cause of the transatlantic success.

To determine the existence of reflection from such an ionized medium, efforts were made to observe it by the most direct method possible. For such observations radio waves were transmitted from the Bell Telephone Laboratories' experimental station at Deal, New Jersey, to a receiving laboratory forty-seven miles away, near Mineola, Long Island. If there were a reflecting layer in the upper atmosphere, a second path for the waves would be available, much longer than the direct path along the ground, and signals traveling over the reflected path, symbolized in Figure 1, would take longer to arrive than those using the more direct course. Hence, reception of primary signals and then, a trifle later, of auxiliary signals would be evidence for the existence of such a reflecting layer;

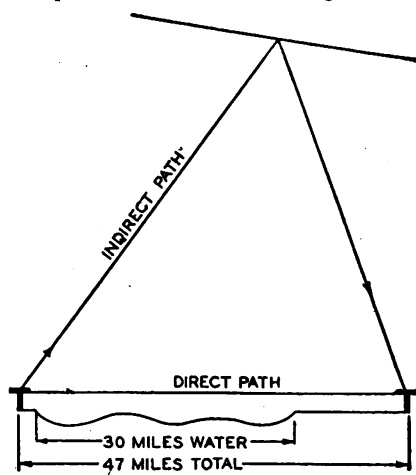


Bell Telephone Laboratories, Inc.

HE TRACES THE TRAILS OF RADIO WAVES

Raymond A. Heising, shown above, is known everywhere that broadcasting exists as the inventor of the Heising modulation system, used in all radiotelephone transmitters. He is an authority on all phases of radio transmission, and this article incorporates some of his most recent discoveries on the behavior of radio waves in the upper regions of the earth's atmosphere.

from the time interval between original and auxiliary signals the difference in length of the paths could be computed, the speed of radio waves being known.



THE TWO PATHS OF THE TEST BROADCAST WAVES

FIGURE 1: This diagram shows the probable paths of the transmitted waves in the tests which were made between Deal, New Jersey, and Mineola, Long Island. The distance between the two stations was 47 miles, and the virtual height of the reflecting region was 150 to 400 miles.

Signals of the type shown at A in Figure 2 were transmitted. High-frequency power was radiated for periods of approximately 0.001 second at intervals of about 1/60 of a second. Signals similar to those at B in Figure 2 were received with a sharply tuned set, and were recorded by an oscillograph. When there were two paths for transmission of the wave—a path with reflection from an overhead layer in addition to the direct path along the ground—two signals were received for each group of waves, transmitted as represented at C in Figure 2. This is strong evidence for the existence of the postulated zone of ionization. Drawings of the oscillograms of actual received signals are shown in the diagrams in Figures 3 and 4.

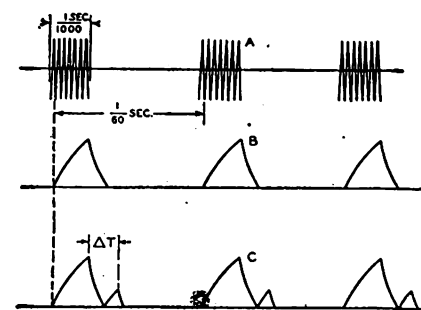
Even more than two paths were observed in many instances. Some of the paths would occur as represented in Figure 5, where paths B, C and D have one, two and three reflections respectively from the reflecting layer. The diagram at the right of the drawing shows the type of signal to be expected under such circumstances. As

many as four signals may be received for each signal transmitted. Oscillograms in which signals arrived by several different paths are represented in Figures 3 and 4.

The theory of the reflecting layer thus postulated requires the presence of free electrons. When an electromagnetic wave traverses this reflecting region, the unattached electrons are moved by the influence of the wave and absorb energy from it. On account of their mass and charge and the presence of the earth's magnetic field, the electrons in their movements reradiate the absorbed energy slightly out of phase with the passing wave; in doing so they change the effective velocity within the refracting zone. This variation in effective velocity is, of course, the cause of refraction.

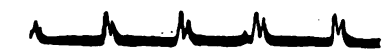
The electrons in this reflecting layer are supposed to come from two sources. There is good reason for believing that electrons are thrown out of sun spots and reach the earth. Other electrons are freed by the ultra-violet light which comes from the sun, and, reaching the atmosphere, knocks off electrons from molecules of its gases. It appears from experiments that the free electrons in the ionized regions of the atmosphere are produced by both of these causes; electrons from the sun spots are received both day and night, since their paths are bent by the earth's magnetic field, while ionization of the air molecules takes place on the sunlit side of the earth.

The free electrons do more, however, than refract or reflect the waves. When an electron absorbs energy from a passing wave and executes an oscillatory or circular motion in the atmosphere in its absorbing and radiating process, continuance is insured only as long as noth-



HOW VARIOUS TYPES OF SIGNALS RECORD

FIGURE 2: The wave trains shown at A are those of steady high-frequency power radiated periodically. At B is the type of signal received on an oscillograph with a very selective set. This signal travels the direct path. At C is the type of signal received when two paths existed. From the measurement of the time difference, ΔT , the difference of length between the direct and indirect paths can be computed.



WAVES THAT TOOK MORE THAN ONE PATH

FIGURE 3: The upper graph is an oscillogram of a signal, received on a wavelength of 57 meters, in which the character of the curve indicates that both a direct and a reflected wave were received. A calculation of the time difference between the incoming signals indicated that the height of the reflecting layer was 221 miles. The lower graph also shows both direct and reflected waves, the latter being reflected from a height of 155 miles.

ing gets in the way. If there are many gas molecules around, the moving electron may strike one and lose a large part or all of its energy, or it may be deflected in such a way that the energy remaining is radiated at random, no longer contributing to the passing radio wave. In such a case the free electron must absorb more radiation before it can contribute further to the passing wave. The presence of gas molecules in the region where the free electrons occur thus causes absorption of energy from the wave. Under these circumstances the wave may be reduced in intensity, often to a very low value.

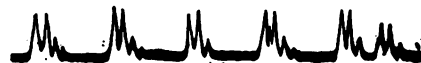
It has been shown in a paper by Nichols and Schelleng* that the frequency of collision with molecules is related to the magnitude of absorption. If the gas molecules are relatively close together—if the air is dense—a free electron can scarcely move under the influence of a passing wave, since the gas molecules block the way, and so neither absorption nor reflection occur. If the gas molecules become less numerous, the free electrons can move more readily. At a certain air density, therefore, maximum absorption occurs, because at that stage it is certain that practically all the electrons lose their energy by collision with gas molecules before they have had a chance to radiate again any appreciable part of it. As the density of the gas is still further reduced the molecules become so far apart that the electrons can execute a great number of oscillations before losing their energy by collisions. Density of the air thus determines locations of the zones at which waves are absorbed or reflected.

Atmospheric density is greatest at the earth's surface, and rapidly becomes less as the altitude increases. At a

height of about fifty miles the density is reduced to the value causing the greatest absorption, and about twenty-five miles higher is so much less that the electrons can execute their oscillations with only rare loss of energy to the gas molecules in collisions; reflection, or more properly refraction, can therefore occur. That region where the air density is suitable for absorption is called the "absorbing region," while the zone higher up in which reflection or refraction may occur is called the "refracting region."

When an electromagnetic wave travels between two points separated by a considerable distance, on account of the earth's curvature, the wave received at a distance must travel up to the refracting region, and then turn downward to strike the earth at the receiving station. The wave must, therefore, pass through the absorbing region twice. On the way up, if many free electrons are present in the absorbing region, the energy of the wave may be so cut down that little is left to be reflected, and after reflection it will be cut down further on the return to earth. Long-distance radio communication can, therefore, be secured only by means of those waves which can make two or more passages through the absorbing zone without undue attenuation.

The experiments reported in the paper at the Radio Institute appear to support the hypothesis that free electrons are produced in the absorbing region of the atmosphere by ultra-violet light from the sun, making absorption thus a daylight phenomenon. It is not equivalent for all radio waves, but varies with the wavelength. At 15 to 20 meters it is very small, is fairly great for wavelengths around 100 meters, and is a maximum just over 214 meters; beyond this point it seems to become considerably less.



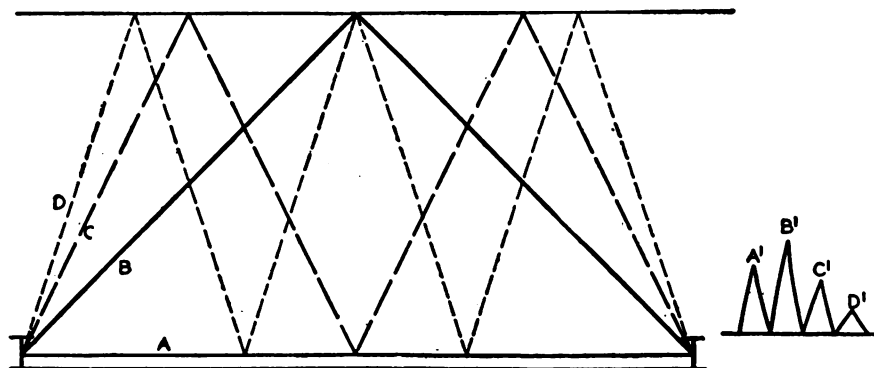
A GRAPHIC STORY OF REFLECTED WAVES

FIGURE 4: Both of these graphs show signals that took more than one path between transmitter and receiver. In the upper graph the computed lengths of the four paths that the signals took were 47, 408, 809 and 1,240 miles. The wavelength was 57 meters. In the lower graph (another 57-meter signal) the three paths that the signal took were 47, 441 and 882 miles.

The free electrons present in the refracting region at night appear to be those from the sun. There are also some "hold-over" electrons formed during the day and remaining uncombined with the positive gas ions. The electrons from the sun appear to be more numerous or more influential, for the data show that the refracting region moves up and down in a manner not compatible with other hypotheses. The apparent height of the refracting region at night is 150 to 400 miles. During the day, the larger part of the free electrons in the refracting region are caused by ultra-violet light from the sun. Since this light produces free electrons at altitudes as low as 16 miles, the apparent height of the refracting region is much lower during the day than at night.

From these observation we have concluded that the refracting region does not remain in any position, but moves up and down at a varying rate. A

(Continued on page 172)



HOW ONE SIGNAL CAN BE RECEIVED FOUR TIMES

FIGURE 5: When the reflecting layer is parallel to the earth's surface, more than two paths can be taken by radio waves. In this diagram four paths are indicated, A, B, C and D, with progressively increasing distances that the signal has to travel to reach a given distance on the earth's surface. The small diagram to the right shows the type of signal received from waves taking each of these paths.

* Bell System Technical Journal, April, 1925.

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A turn of the dials of the Teletrol brings in station after station that the average broadcast listener has never heard of before—short-wave broadcasters from fabulous distances, amateur DX hounds, and the fascinating mystery of the short-wave code stations.



The Teletrol Wave Lifter

By CARL DORF

SHORT-WAVE broadcasting and reception have recently been attracting, more and more, the attention of radio fans and listeners. The tremendous distances that may be covered on short waves, and the freedom from fading with its accompanying distortion, have been demonstrated by the pioneering of short-wave stations, especially KDKA and WGY. The average reliable service range of 500-watt broadcasting stations on the usual broadcasting wavelengths is not more than 15 to 40 miles where really good reception is to be expected. On short waves—that is, wavelengths below 100 meters—broadcast signals are reliable for more than ten times that distance. To demonstrate, it is only rarely that listeners on the European side of the Atlantic pick up American broadcasting stations that operate on the regular broadcast band, but the short-wave station at Pittsburgh has, during the last two years, been consistently received as far away as Australia, which is half-way round the world. During the last winter the British Broadcasting Company has regularly broadcast to its British listeners complete programs from the

The Teletrol wave lifter is the key to a new and fascinating wonderland of radio. Short-wave reception is a luxury enjoyed by few radio fans, and yet this crop of wavelengths can be harvested nightly by the use of the simple device described here, that may be used with any broadcast receiver. In the region of the "little" waves there is no interference, and static is reduced to a minimum. The Teletrol catches these short waves and "boosts" them so that they become audible through your present receiver.

American short-wave stations. Their plans for the coming winter include a regular service of this kind. This is an indication of the reliability of long-

distance short-wave transmission and reception.

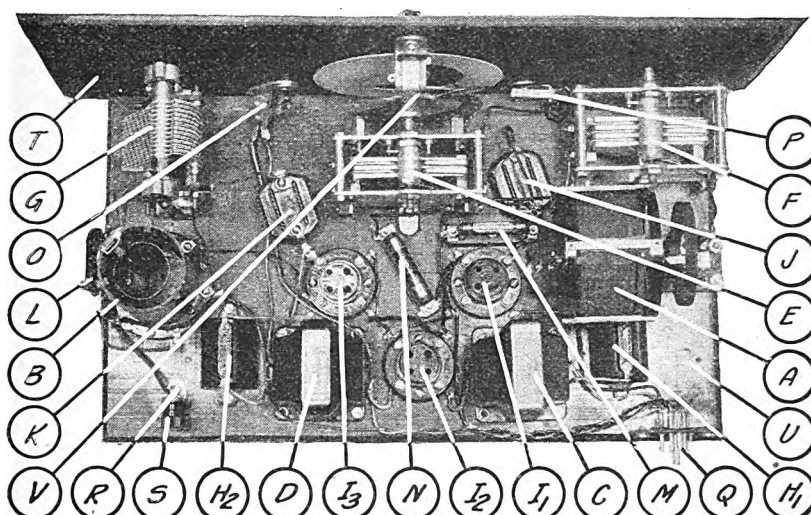
There are now at least 36 stations scattered throughout the country operating on short waves that can be picked up on a suitable short-wave receiver. Furthermore, stations in England, Germany, Holland and Japan are now operating regularly at these high frequencies with interesting programs that cannot possibly be received here in America through any other system. Amateurs are now receiving them even during the daytime on short-wave receivers. Up to the present time ordinary broadcast listeners have been as cut off from these excellent programs as if they never existed.

It is only recently that the difficult problem of efficient short-wave reception has been carefully and energetically studied and a reliable system of reception worked out. As a result, a unit has been evolved for attaching to any standard radio receiver for opening up the short-wave band to the regular broadcast listener.

The problem has resolved itself into the development of a unit which can be placed ahead of the regular broad-

POPULAR RADIO WORK SHEET

THE TELETROL WAVE LIFTER



A TOP VIEW OF THE TELETROL

FIGURE 1: The building of this unit requires no more skill than that necessary in constructing standard receivers, as this view shows.

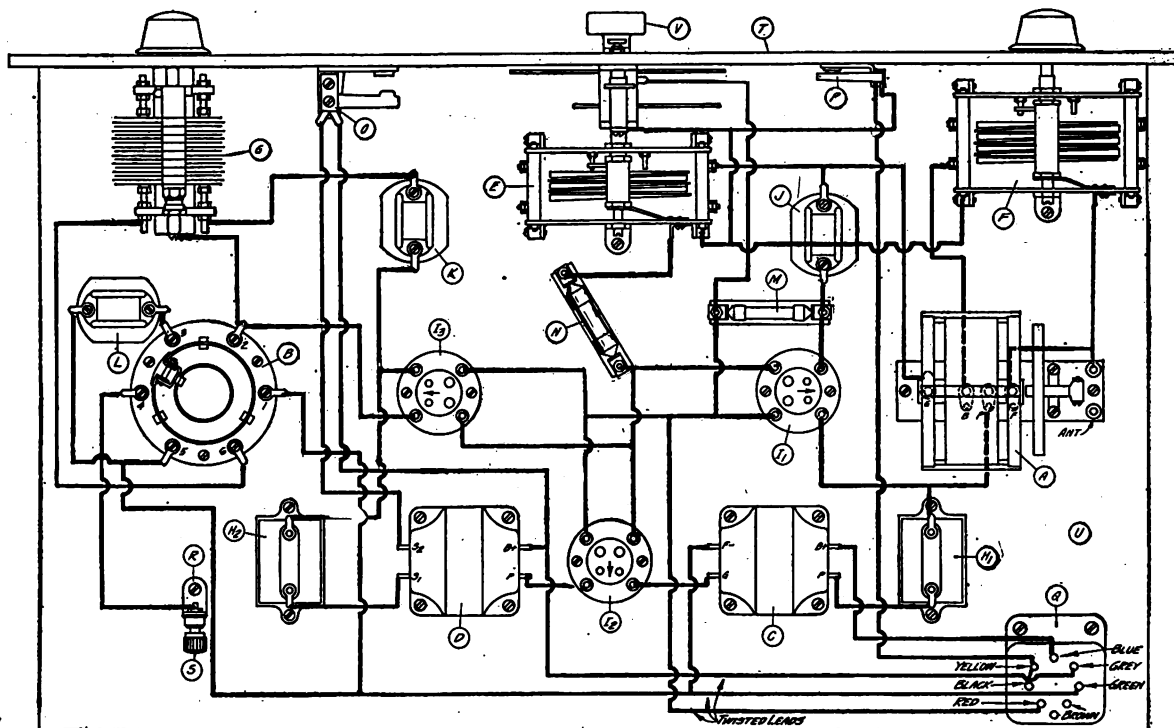
LIST OF PARTS USED IN BUILDING THIS UNIT

COST OF PARTS—Not over \$65.00

A—Aero coil set, type LT-125;
B—Aero coil, type 55;
C—Samson symphonic transformer;
D—Samson choke, type O;
E—Cardwell condenser, type 167-E;
F—Cardwell condenser, type 168-E;
G—National condenser, .0005 mfd.;
H1 and H2—Samson R. F. choke coils;
I1, I2 and I3—Na-ald sockets, type 481-XS;

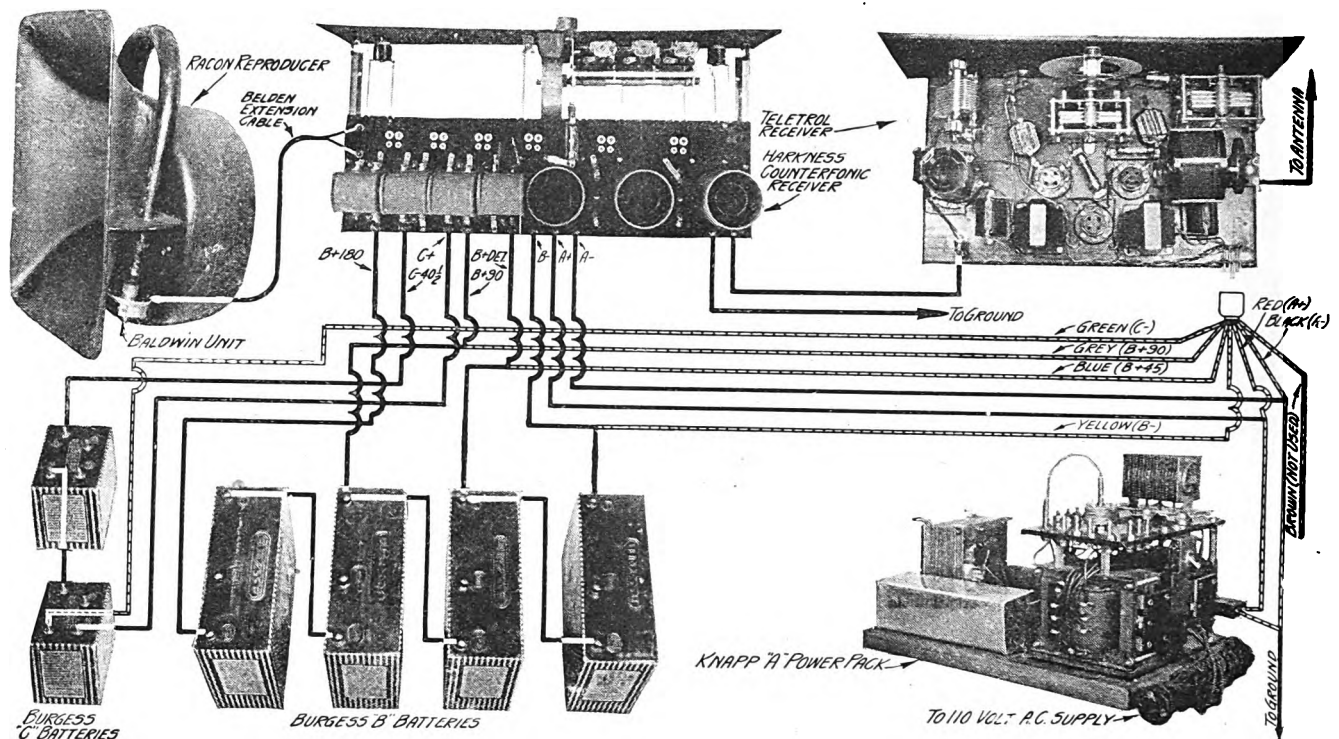
J—Sangamo fixed condenser, .00025 mfd.;
K and L—Sangamo fixed condensers, .006 mfd.;
M—Durham grid-leak, 6 megohms, with mount;
N—Amperite, $\frac{3}{4}$ ampere;
O—Yaxley S. C. jack;
P—Yaxley filament switch;
Q—Yaxley cord and plug;

R—Brass angle, $1\frac{1}{4}$ by $\frac{1}{2}$ inch;
S—Eby binding post;
T—Composition panel, 7 by 18 by $\frac{3}{16}$ inch;
U—Wooden baseboard, 9 by 18 by $\frac{1}{2}$ inch;
V—Marco illuminated dial;
15 feet of Corwico Braidite hook-up wire;
Mounting screws, solder, etc.



THE PICTURE WIRING DIAGRAM

FIGURE 2: All the wiring is done above the baseboard, and is shown in this diagram in solid blue lines. The instruments are outlined in black.



HOW TO HOOK UP THE TELETROL TO YOUR BROADCAST RECEIVER

FIGURE 3: The Harkness Counterfonic Six, whose construction was described in the January number of POPULAR RADIO, is shown as an example of standard receivers that may be used with the Teletrol. Note that only a simple change in the antenna and ground connections is necessary to plug in the Teletrol.

cast receiver and which would tune to the incoming short-wave signals, on wavelengths from about 13 meters up to 100 meters, and so convert them that they will be accepted by the high-frequency amplifier in a standard radio receiver, operating from 200 to 550 meters.

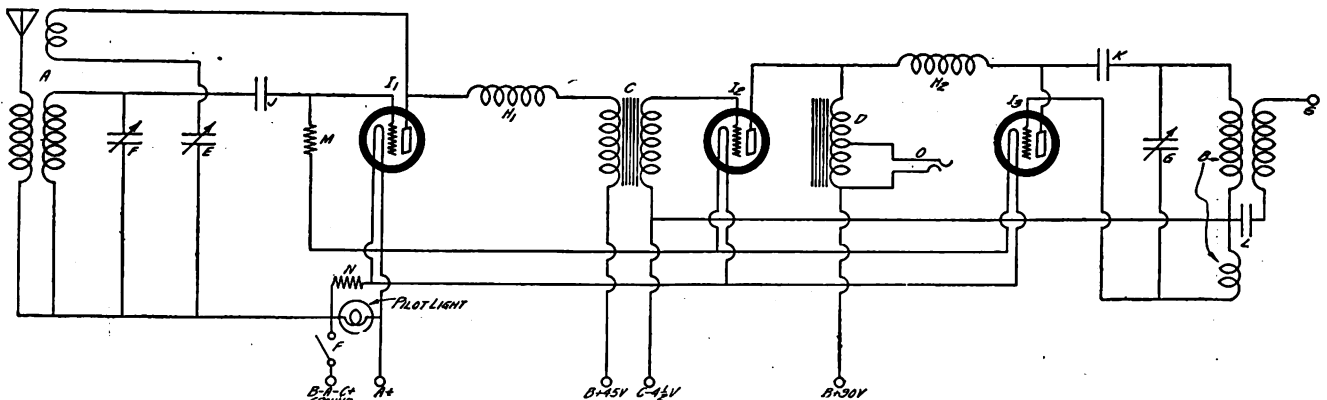
The solution, when finally found, was so simple that it was almost unbelievable. It resolved itself into the design of a rather ordinary, but reliable, short-wave single-valve receiver with a stage of low-frequency amplification in com-

bination with the already recognized Heising modulation system now used by all broadcasting stations, and a local oscillator that can be tuned to any particular wavelength in the broadcast band; altogether a three-valve circuit.

This is the system used in the "Teletrol" Wave Lifter, developed by two young engineers who have for years pioneered in short-wave reception. These two experimenters, Arthur L. Budlong and Bert E. Smith, well known among the members of the Amateur Radio Relay League, have combined the units

spoken of above into a converter that performs admirably, and that may be connected to any radio receiving set now used for regular broadcast reception.

A study of the schematic wiring diagram of the new unit, shown in Figure 4, discloses the component functions of the regenerative detector and the Heising modulation scheme connected to a tunable oscillator, working as a unit, for "wave lifting." The unit employs three vacuum valves of special
(Continued on page 150)



THE CIRCUIT OF THE TELETROL

FIGURE 4: The Teletrol is not a complicated electrical device, as the above circuit diagram shows. It solves itself into a simple short-wave receiver circuit, shown at the left, supplemented by a stage of low-frequency amplification, shown in the center; its output modulates the oscillator circuit shown at the right, and thus lowered to a frequency that is acceptable to a standard broadcast receiver.

What Radio Receivers Can Do With the New Magic of Shielded-Grid Valves

Just what are the possibilities of the new shielded-grid valves to the experimenter and the broadcast listener? How will they affect radio receiver design and operation? In the article below you will find an answer, drawn from actual tests on one of the first receivers designed to utilize these sensational products of radio ingenuity.

By LAURENCE M. COCKADAY

THE advent of the shielded-grid valve, especially as a high-frequency amplifying device, has made radio engineers revise many of their notions concerning this form of amplification. Whereas the amounts of amplification per stage were once of the order of *units*, now they are speaking of per-stage amplifications running anywhere from 25 to 50.

Since the article on the shielded-grid valve in the November, 1927, issue of POPULAR RADIO, an American valve of this type has been placed on the market, and the interest in receiver designs incorporating the new type of valve, as a workable unit, has been growing rapidly.

There is a common misconception on the part of the public that this new type of valve may be incorporated in almost any existing set without much change. This is not true. The new device is so extremely sensitive that it

entails certain very definite precautions of design in the receiver with which it is to be employed, and usually it will be found that a general redesigning of the set is necessary. The shielded-grid valve must be used in a completely shielded high-frequency amplifier, in order to give stable operation at the enormous amplification that it is capable of producing.

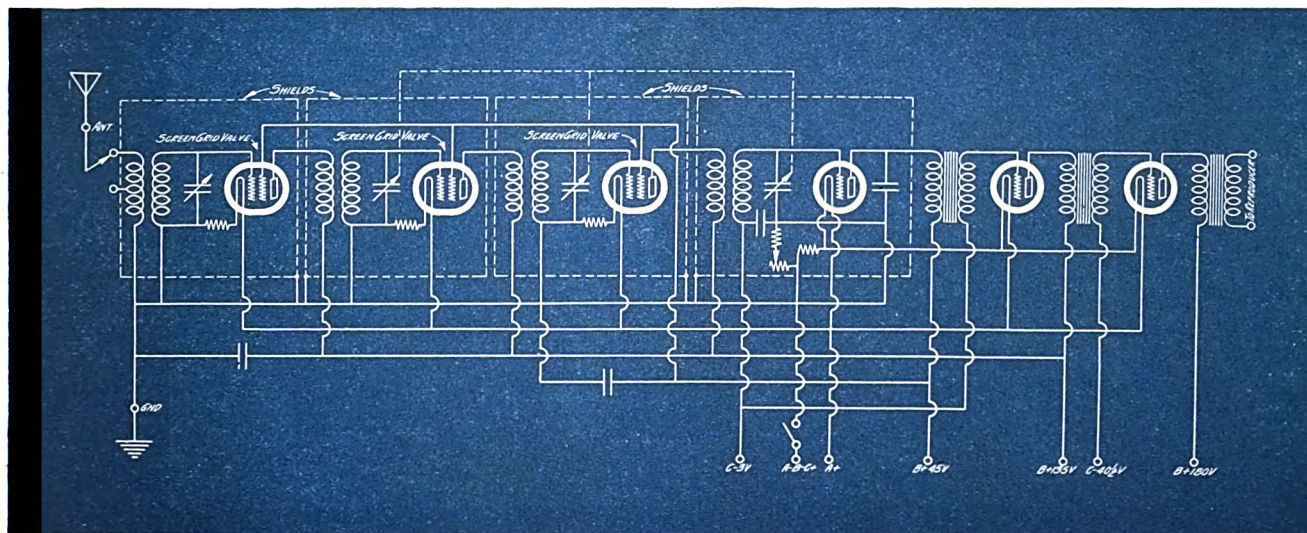
One of the great difficulties encountered in the design of circuits and apparatus for use with this shielded-grid valve lies in the fact that although the effective input capacity of the new valve is extremely low, its capacity, looking out of the plate circuit, is of a very high order. This effect, when using conductively coupled tuning circuits, is naturally going to affect the complete amplification curve over the broadcast frequency range to a great extent, and if the design is not exceptionally carefully worked out the amplification curve will

be far from being equal over the whole range, but will have a definite peak with a decided falling-off at each end.

Another condition in the new valve is its high output impedance. This affects materially the design of shunt-plate-feed circuits and again calls for special consideration in the inductance and capacity tuning arrangement. It is imperative that the coils used in the circuit have an efficient form factor and that their impedance when tuned to resonance be of the highest possible value. The coupling condensers used should be of a relatively low impedance.

Other problems, such as shielding the control grid circuit from the plate circuit without increasing the effective capacity across the valve, and taking care of the mechanical design, must first be overcome before the high amplification that may be obtained theoretically is realized in practice.

One of the first receivers to be intro-



A RADIO CIRCUIT EMPLOYING THE NEW VALVES

FIGURE 1: Above is the schematic wiring diagram of the Silver Shielded-Grid Six, employing a high-frequency amplifier of three shielded-grid-valve stages, shown at the left. The detector and low-frequency amplifier at the right are of standard design. The individual shielding of the high-frequency and detector stages is an essential feature of the design. Note also that the shielding grids are connected together to the "B" positive (+) 45-volt lead. The low-frequency amplifier is of standard design.

duced to the public, with an arrangement of circuits specially designed to take care of the shielded-grid valve as an amplifier, is the Silver Shielded-Grid Six Receiver. This receiver uses three stages of shielded-grid-valve amplification followed by a standard vacuum valve detector and two stages of standard low-frequency amplification.

With this type of valve, it is of the utmost importance that the control grid and its associated circuit (the input tuning) be statically shielded from the plate or output circuit.

Referring to the schematic wiring diagram in Figure 1, it will be noted that the plate connection of each of the three shielded-grid valves is placed close to the side of the stage shield, so that it runs directly out of the can and into the input circuit of the following valve. It will also be noted that the shielding grids of all of the valves are connected together and a 45-volt positive potential is placed on them. From a high-frequency standpoint this shielded grid is placed at practically the same potential as the ground. This prevents feed-back that might otherwise cause what is ordinarily known as *regeneration*. This means that in a properly designed receiver the maximum amplification can be obtained without any accompanying instability.

It must also be remembered that the new shielded-grid valve has a filament

that is different from the standard valves, in that it consumes but a small amount of filament current, at about half the usual filament voltage. This variation from the standard characteristic is taken care of in the Silver Six by a series resistance and also by three fixed resistors, one in each stage. These last resistors also furnish the proper "C" bias, in the voltage drop across them, for the control grid circuit. These fixed resistors may be seen in Figure 2. The resistors are placed at the right of each shielded-grid valve. The terminal for the control grid is brought out at the top of each valve instead of in the base. This helps in spacing the terminals of the plate and the control grid.

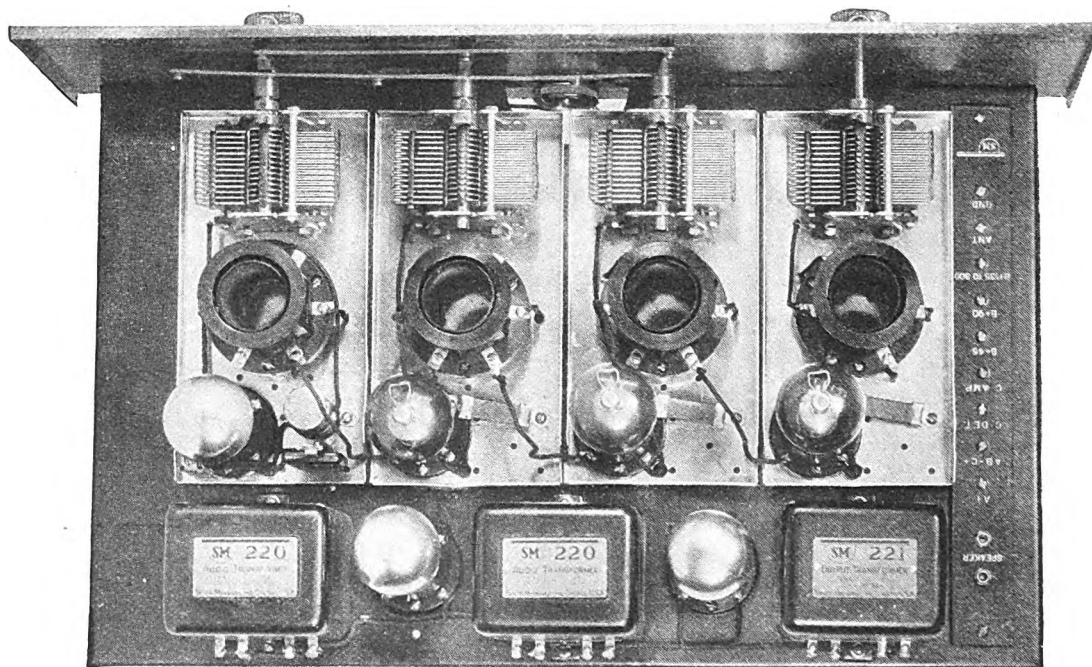
Referring again to Figure 2, the first three stages on the right are the high-frequency amplifier stages, while the fourth stage at the left contains the input tuning to the detector, and the associated grid condenser and standard vacuum valve detector. In this case a 312 type valve is used for the detector and the first stage of low-frequency amplification, which is coupled with a low-frequency amplifying transformer. A second transformer couples this valve to a 371 type valve, which is used as a power amplifier, in conjunction with an output transformer. The general construction of the complete receiver follows, in layout, the standard Silver design, except as specialized in the high-

frequency amplifying stages incorporating the shielded-grid amplifying valves.

The coils in this receiver are loosely or inductively coupled, but are of special ratio to take care of the large amplification that can be obtained with this new type of valve. Ordinary coupling inductances, such as used with the old-style amplifying valves, are practically useless so far as a consideration of maximum amplification is concerned. It is also a misconception that plate tuning must be used with the shielded-grid valves.

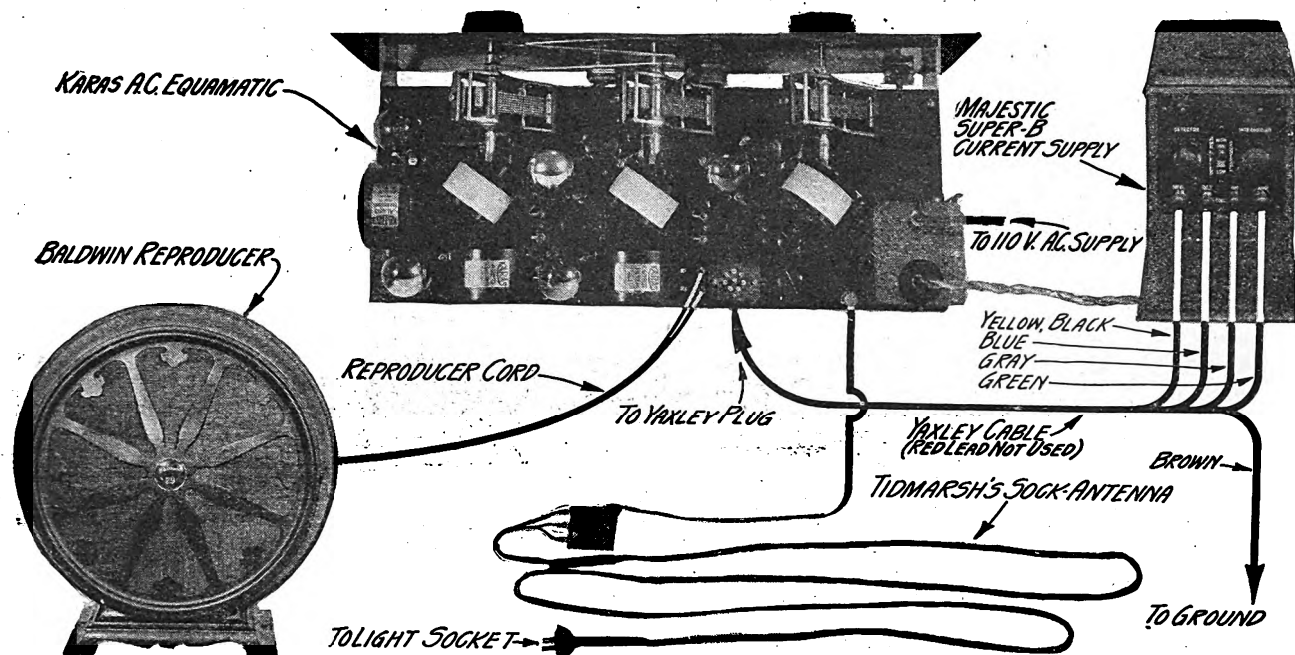
While experimenting with this new receiver in the POPULAR RADIO Laboratory, it was interesting to note that even a slight movement of the shields or a partial removing of one of the shields caused such a change in the amplifying conditions that reception varied immediately and became unstable. However, with the shields firmly in place, an enormous amplification was possible.

In tests on this receiver it was not difficult at all to bring in distant stations that have heretofore been considered on the very fringe of good reception, with a volume ordinarily associated with local reception. This may sound like an exaggeration, but when it is considered that the total amplification in a receiver of this type may go as high as 15,000 to 25,000, such great distance-getting ability does not seem to be at all impossible.



A VIEW OF THE SHIELDED-GRID SIX FROM ABOVE

FIGURE 2: The three high-frequency stages and the detector stage are shown in their shield cans with the tops removed. The low-frequency amplifier is at the bottom. The clips at the tops of the valves are the control grid connections. The shielding grid leads come into the valves through their bases. Note that the plate leads from each valve to the transformer of the succeeding stage is made as short and direct as possible; this is highly important for the proper operation of the valves. The transformers themselves are of very different design from those used in ordinary high-frequency amplifiers.



A PLUG-IN OPERATING COMBINATION FOR THE KARAS

FIGURE 1: By using the "B" power-pack and the socket antenna shown in the above diagram, the AC Karas receiver may be made an entirely socket operating set, with no batteries to run down and no troublesome outdoor antenna to cause inconvenience or trouble to the set owner.

13 Features in the AC EQUAMATIC

Light-socket operation takes a great step forward in efficiency and quality in the adaptation of AC valves to the well-known Equamatic circuit, as embodied in the new AC Karas Equamatic receiver described in this article. In addition to supplying all its own "A" current, the new 5-valve receiver features two-dial tuning and a variable coupling feature that gives equal amplification at all frequencies in the broadcast range.

By ALBERT G. CRAIG

THIS new receiver is especially designed to use the new AC valves in the well-known Equamatic type of circuit, and operates entirely without batteries. It employs a variable coupling feature that allows practically equal amplification at all of the frequencies that lie within the broadcast range. Only two tuning controls are used on the main panel, one of them for tuning the antenna circuit and the second for tuning the second stage of high-frequency amplification and the detector circuit. These two latter circuits are controlled by two condensers that are harnessed together and operated by a single knob. All of these condensers are equipped with rotatable primary coils attached on the condenser shafts, so that the coils themselves revolve inside of their secondary coils when the condensers are rotated from the low wavelength range to the high wave-

length range in the broadcast band.

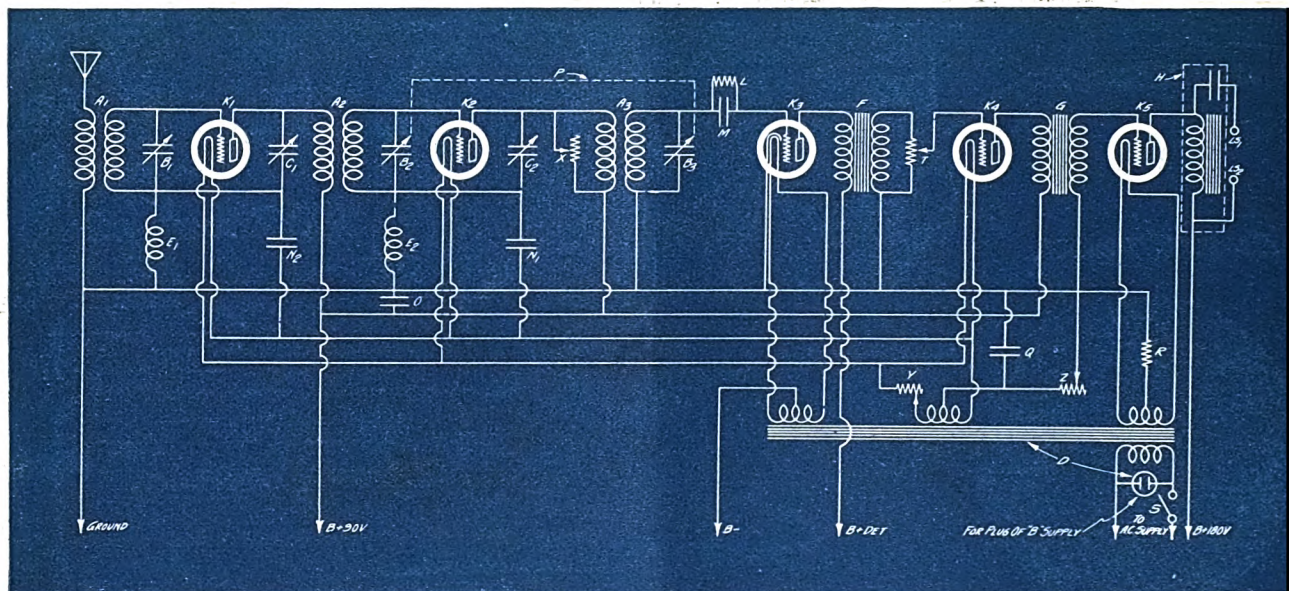
The receiver incorporates two stages of transformer-coupled, low-frequency amplification with an efficient volume control. It employs an output filter, thus protecting the loudspeaker and reducing second harmonic distortion.

A study of the schematic circuit given in Figure 2 will bring to light some more interesting features of the receiver. It will be noticed that two high-frequency choke coils, E1 and E2, are connected in a combination arrangement with two small fixed condensers, N1 and N2, and two small balancing condensers, C1 and C2, to furnish the necessary stability for the two high-frequency amplifying circuits. The arrangement is in reality a balanced bridge that may be easily adjusted for controlling regeneration and eliminating oscillation at any particular frequency. In other words, condensers C1 and C2

may be adjusted so that at one particular wavelength the set may be stabilized so that it will not whistle or howl. This same balance, however, may be maintained throughout the whole field by the automatic control of the variable primary coupling coils already mentioned.

It will also be noticed that three of the new Tele vocal AC-226 type valves are used in the first, second and fourth sockets, while a Tele vocal AC-227 type valve is used in the third socket. A standard Tele vocal TC-171 power valve is used in the fifth or output socket.

As will be seen from Figures 3 and 4, the physical layout of the new receiver is neat and efficient, which makes for easy construction. The tuning unit of the receiver occupies the center portion of the sub-panel and the amplifying and power apparatus are placed along the back edge. The sub-panel it-



THE SCHEMATIC CIRCUIT OF THE KARAS RECEIVER

FIGURE 2: The standard Equamatic circuit for the high-frequency amplifier is shown above adapted for use with valves whose filament current is drawn from the Karas AC-Former, D. The low-frequency amplifier at the right is of the standard two-stage transformer-coupled type with an output filter, H.

self is mounted on three straight brackets that support the whole assembly and furnish a means for binding together into a compact unit the front panel and the set proper.

The receiver when installed in a standard cabinet presents a very pleasing appearance and will give much improved results over the older and more familiar DC model formerly known as the Two-dial Equamatic.

How to Construct the Receiver

The first job to be done in building this receiver is to mount all of the parts on the top of the sub-panel, W, which may be procured already cut and drilled.

The parts should be mounted as shown in Figure 4 and turned in the relative positions shown in the diagram in Figure 5. These two illustrations indicate the details of the mounting

work so clearly that no additional information will be necessary here.

The parts to be mounted underneath the sub-panel, W, should be attached, as shown in Figure 3, and the three brackets, BR1, BR2 and BR3, should be fastened by means of two screws to each bracket.

Now the two condensers, B2 and B3, should have attached to their shafts the coupling gear that allows them to be tuned as one single unit. Of course, the shaft of condenser B2 must be shortened so that it will not protrude through the front panel. The two control units, T and X, should be attached to the front panel, as well as the switch, S, in the positions indicated. Then the front panel, V, should be screwed tightly to the three brackets, BR1, BR2 and BR3. The two vernier dials, U1 and U2, should then be attached and adjusted so that they will read "100"

when the condenser plates are set "all in."

This completes the construction work and the wiring may be started.

How to Wire the Receiver

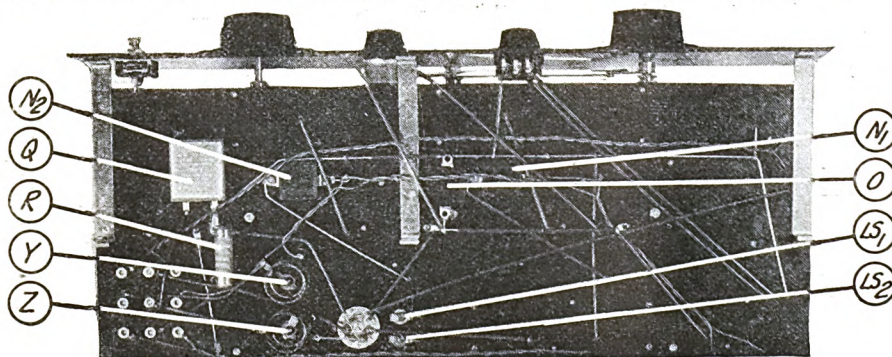
The receiver itself should be wired up exactly as shown in the picture wiring diagram in Figure 5.

In this drawing all of the wiring is shown in heavy red lines. The solid red lines indicate that portion of the wiring which is to be done above the sub-panel, W, and the dotted red lines show the wiring that is run down underneath the sub-panel. All of the instruments themselves are outlined in black.

In wiring up the receiver, it is recommended that an insulated flexible wire be used, such as Celatsite. It will be noticed that the wiring diagram in Figure 5 specifically indicates the portions of the wiring that must be twisted together. This is done to prevent inductive effects from the alternating-current filament circuits that might produce undesirable hums.

After the wiring has been completed, it should be checked over carefully with the picture wiring diagram that carries out the form of circuit shown in the schematic wiring diagram in Figure 2. The leads from the power transformer, D, to the switch, S, should be made from the small loop of wire that is located in the opening of transformer, D. This loop of wire should be cut and pulled out to the correct length to reach to the switch, S, and each half of the wire joined to one terminal of the

(Continued on page 151)



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 3: Most of the wiring is done under the sub-panel with Celatsite wire. Note, however, the twisted cables of the AC leads. The sub-panel may be obtained ready drilled, thus simplifying the job of mounting the instruments.

POPULAR RADIO WORK SHEET

THE AC KARAS EQUAMATIC RECEIVER

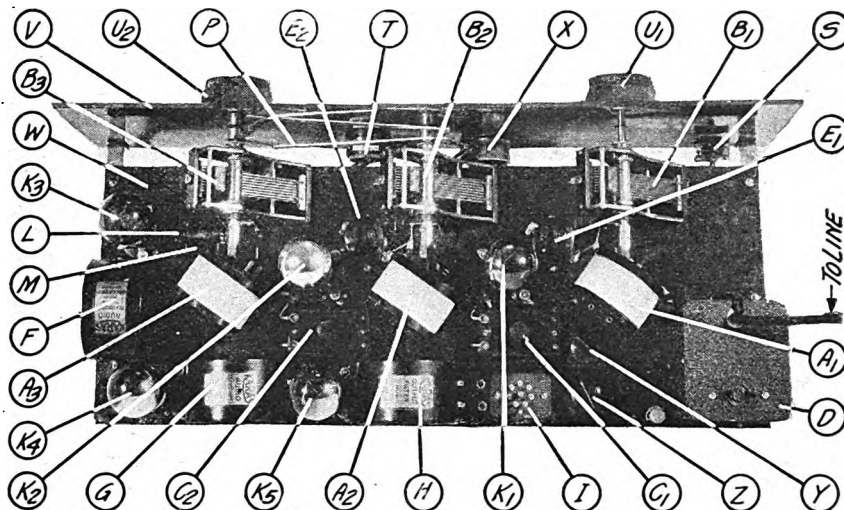


FIGURE 4: THE PANEL LAYOUT OF THE RECEIVER.

LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$115.00

A1, A2 and A3—Karas equamatic coils;
 B1, B2 and B3—Karas variable condensers, .00037 mfd.;
 C1 and C2—Samson balancing condensers;
 D—Karas AC-Former;
 E1 and E2—Hammarlund high-frequency choke coils, 85 millihenries;
 F and G—Karas low-frequency transformers, type 28;
 H—Karas output filter;
 I—Yaxley connector plug;
 J—XL binding post;
 K1, K2, K4 and K5—Benjamin Clea-tone vibrationless sockets (4-prong);
 K3—Benjamin 5-prong socket;

L—Durham metallized grid-leak, 2 megohms;
 M—Carter mica fixed condenser, .00025 mfd., with grid-leak clips;
 N1 and N2—Carter mica fixed condensers, .00015 mfd.;
 O—Carter mica fixed condenser, .006 mfd.;
 P—Karas coupling gear for condensers B2 and B3;
 Q—Carter by-pass condenser, No. 210, 1 mfd.;
 R—Electrad truvolt fixed resistor, type B-20, 2,000 ohms;
 S—Carter power switch, type No. 110;
 T—Electrad potentiometer, type E, 500,000 ohms;

U1 and U2—Karas Micrometric tuning dials;
 V—Drilled and engraved panel, 7 by 24 by 3/16 inch;
 W—Drilled sub-panel, 9 by 23 by 3/16 inch;
 X—Carter rheostat, No. M-75, 75 ohms;
 Y—Carter rheostat, No. MW-1/5, .2 ohm;
 Z—Carter potentiometer, No. MW-2,000, 2,000 ohms;
 LS1 and LS2—Carter tip jacks, No. 10;
 BR1, BR2 and BR3—Karas sub-panel brackets;
 10 lengths of Celatsite insulated bus bar.

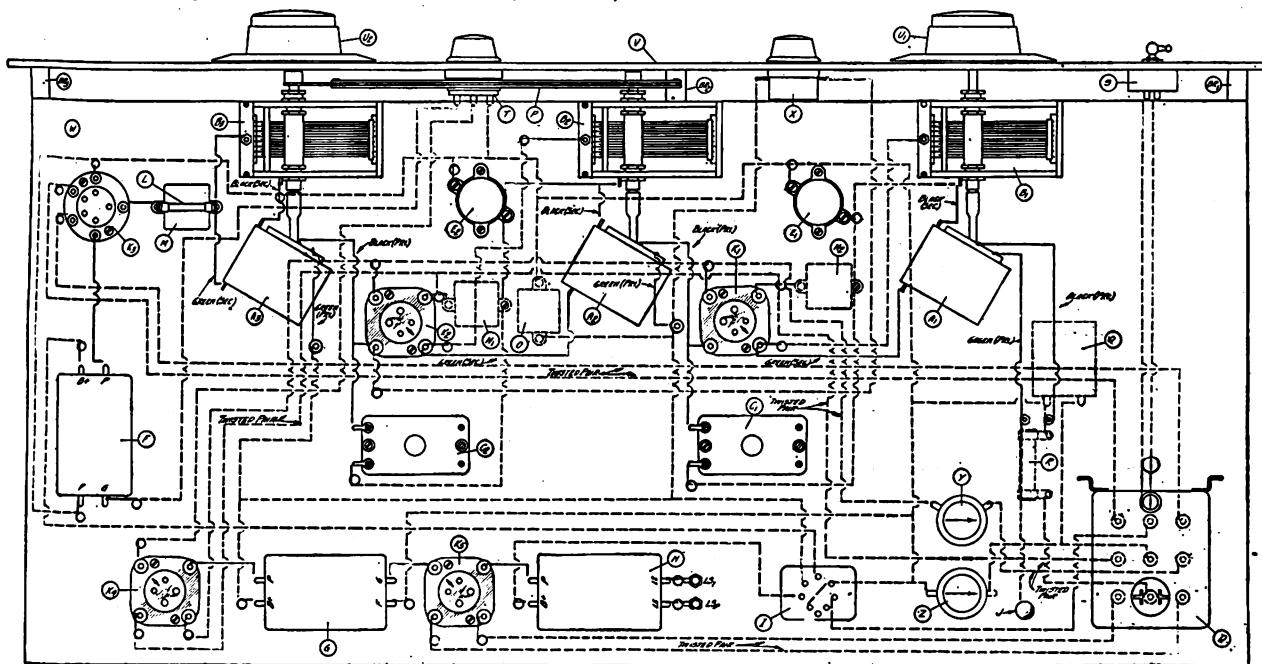
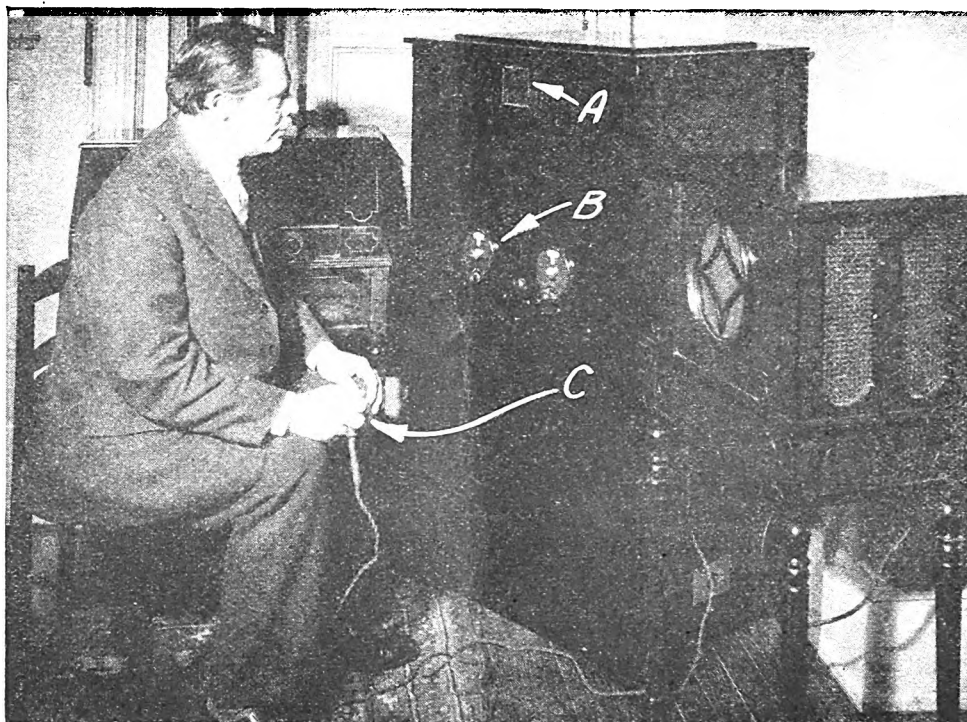


FIGURE 5: THE PICTURE WIRING DIAGRAM OF THE EQUAMATIC.

A BROADCAST LOOKER

At the right is E. F. W. Alexander, of the General Electric Company, with one of the television receivers. At A is the chamber where the image appears; B is the short-wave tuning panel, and C is the resistance that regulates the speed of the motor.



General Electric Co.

Now You Can Be a "Looker-In"!

Fans Everywhere Are Getting Ready
to Tune to Pictures

By BENNETT DE LACY

TODAY we are listeners-in. Tomorrow we shall be listeners-in and lookers-in, for radio television is no longer the dream of engineers. Almost overnight it has become a reality. The vast research that has been conducted during the past five years has finally been co-ordinated and we have today a practical realization of the efforts of yesterday's pioneers.* In Schenectady at the present time there are a number of radio television receivers that daily pick up picture programs over a special 37.8-meter short-wave broadcaster operated by the General Electric Company. The voice is simultaneously broadcast on a wavelength of 379.5 meters from station WGY.

After a careful examination of the

Television has come out of the laboratories at last! It is preparing now to enter into our homes and take its place in our families just as its older sister, broadcast listening, did six years ago. The television apparatus described in this article is built of such parts as radio fans can buy easily, and its construction and operation are such as any person familiar with radio receivers can master. And its results are on the same plane as those of the receivers that caught the ether waves of our pioneer broadcasting stations.

for the reception of picture programs. Not only are these programs being broadcast daily by the General Electric Company's special transmitter at Schenectady, but arrangements are also being made to broadcast similar programs every day from a large Western station.

The apparatus employed in the receiver is amazingly simple, and its construction comes easily within the abilities of the average radio fan. The cost, contrary to what might be expected, is small, for the major portion of the equipment is simply a broadcast receiver for short waves; the additional equipment is in the form of a fractional horsepower motor that can be controlled to run synchronously with the transmitter, an aluminum disc, and a small neon lamp.

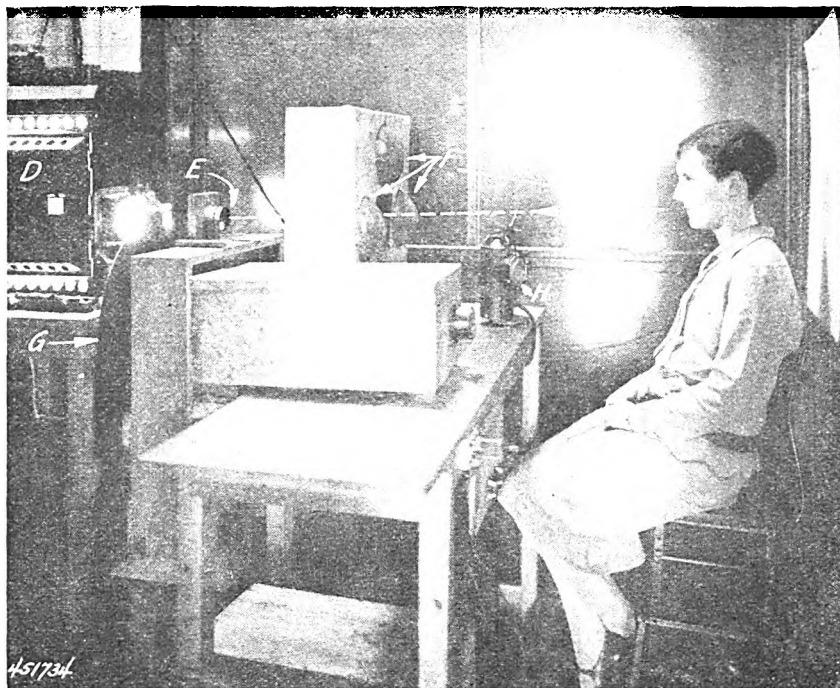
The operation of both the transmitter and the receiver can easily be understood by reference to the diagrams in Figure 1. The transmitter proper is a standard type of circuit connected to a special antenna. Its carrier wave, however, instead of being modulated with sound, is modulated with light.

* Those seeking information on the subject of early experiments in television may find it in the following articles that have appeared in past issues of POPULAR RADIO: "Motion Pictures by Ether Waves" (a description of the Jenkins television apparatus), by Charles Allen Herndon, August, 1925; "The Televisor" (a description of the Baird television apparatus), by Orrin E. Dunlap, Jr., November, 1926; "Radio in 1950," by Dr. Lee De Forest, March, 1927; "Television and Black Light" (a further description of the Baird apparatus), by A. Dinsdale, May, 1927; "What Shall We Do With Television," by Thomas Elway, June, 1927.

television broadcast system by the writer, during a demonstration sponsored by the Radio Corporation of America in collaboration with the General Electric Company, it became apparent that wide-awake radio fans should now begin to prepare themselves

For the ordinary microphone of the broadcasting studio there is substituted what might be called a "light microphone," which takes the form of a series of photo-electric cells that receive the light impulses which are reflected from the object to be broadcast. The light source is an electric arc lamp, and the beam from this lamp falls upon a rapidly revolving aluminum disc in which small holes are drilled in the form of a spiral. As the light from the light source passes through the spirally arranged holes of the disc, a beam of light is caused to scan the face of the object whose image is to be broadcast. The scanning or exploration process is carried on very rapidly, so that the complete surface of the object being broadcast is covered about once every .18 of a second. It will be seen, therefore, that only one beam is operating at one time, and that during the course of one revolution of the disc this beam is swung across every bit of the surface of the object being broadcast.

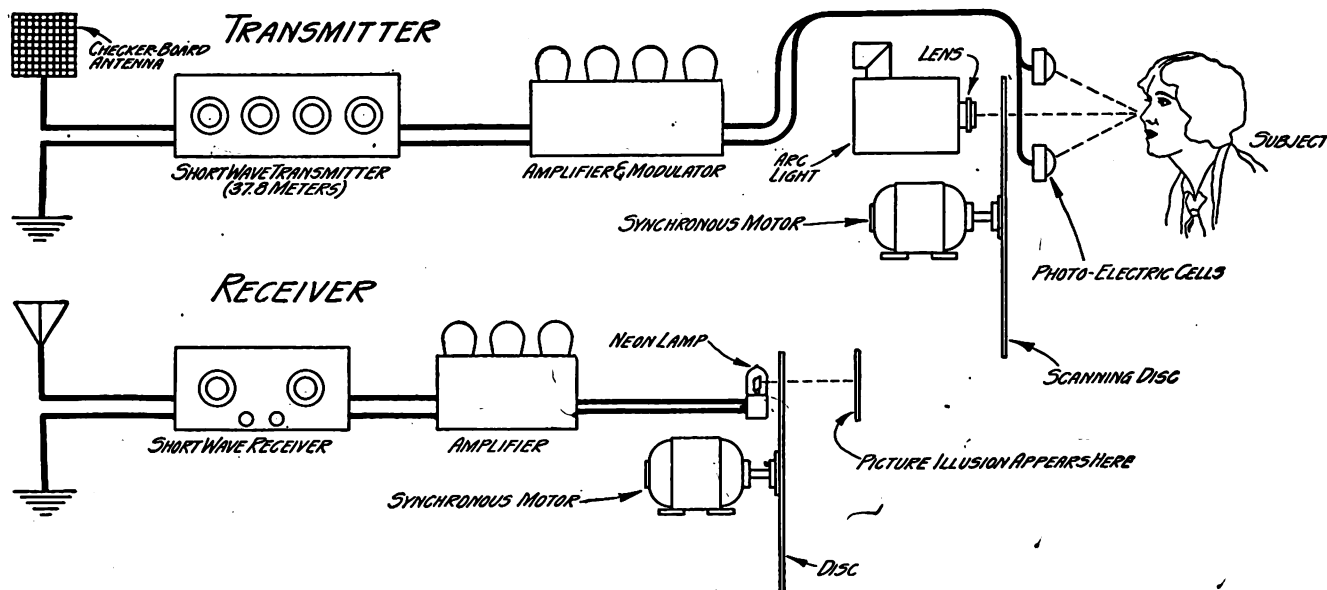
From the object to be broadcast the beam is reflected back to three sensitive photo-electric cells. These cells make up the light microphone, for they permit a varying degree of current to flow through them, depending entirely upon the intensity of the light striking them. For instance, if this beam strikes the hair of a brunette, very little light will be reflected and very little current will flow through the photo-electric cells. Consequently, the wave of the short-



General Electric Co.

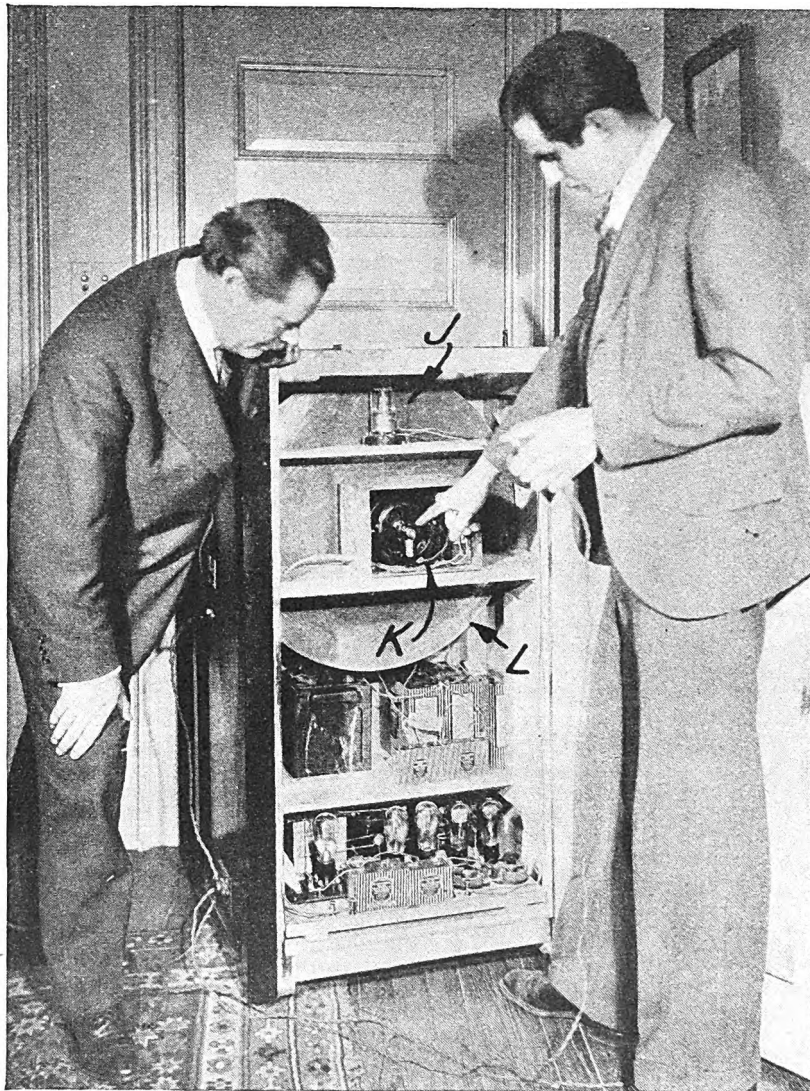
A PIONEER TELEVISION STUDIO

Above is the transmitting apparatus that successfully broadcast moving images to television receivers around Schenectady, N. Y. A beam of light from the arc light, D, passes through the focusing lens, E, and, by means of a rapidly revolving slotted disc in the box behind the photo-electric cells, F, is made to fall successively on every part of the face of the young lady seated before it. The light falling on her face is reflected back into the photo-electric cells at F, where it is converted into electrical impulses whose strength varies with the amount of light reflected. The rest of the transmitting process is simply a matter of using this fluctuating current to modulate the carrier wave of a short-wave transmitter



THE TWO ENDS OF THE TELEVISION BROADCASTING PROCESS

FIGURE 1: These two diagrams show graphically arrangement of apparatus in broadcasting moving images. At the transmitting end, an amplifier, modulator and transmitter of the type familiar in short-wave telephony is connected to the "light microphone" assembly at the upper right. This assembly consists essentially of a light source, a scanning disc and motor, and a photo-electric cell. At the receiving end, the output of a standard short-wave receiver is delivered to the "light loudspeaker," at the lower right, consisting of a neon lamp and another motor and disc similar to that used in transmitter.



General Electric Co.

THE WORKINGS OF THE TELEVISION RECEIVER

Most of the apparatus in this receiver is familiar to the average radio fan. At the bottom of the cabinet is the short-wave receiver and amplifier. Above it may be seen the operating batteries. At the top of the cabinet is the apparatus that converts the output of the receiver amplifier into light images. At J is the neon lamp; its varying light output is reassembled by the revolving disc, L, into the same light pattern that was impressed on the photo-electric cells at the transmitter. The motor that drives the disc is seen at K.

wave transmitter will be practically unmodulated, and darkness will appear at the receiver. On the other hand, if the beam strikes, for instance, a diamond tie pin, a great deal of light will be reflected and a brilliant flash will appear at the receiver.

Thus minute current changes take place in the photo-electric cells which are the result of varying changes in light intensity. The conventional low-frequency amplifier carries these to the transmitter, where they modulate the carrier wave of the transmitter.

The receiver used for television reception is very similar to the type employed by amateur operators throughout the country. It is simply a short-wave set of conventional design provided with

a low-frequency amplifier, constructed of standard parts. In place of the conventional loudspeaker, however, a special neon bulb is used. This neon lamp is sensitive to current changes, but instead of recording these current changes audibly, the amount of light it gives varies. If, at the transmitting end, a great deal of light is being reflected from the broadcast object, more current will flow through the photo-electric cells of the transmitter, and consequently more current will flow from the output of the low-frequency amplifier of the short-wave receiver. This causes the Moore lamp to glow more brightly for an instant, and since there is practically no inertia to these changes the Moore lamp can easily keep

pace with the rapid fluctuations of the scanning device at the transmitter. Interposed between the face of the broadcast observer and the Moore lamp there is an aluminum disc with holes spirally arranged to correspond to those in the transmitter. Both of these discs—the one in the receiver and the one in the transmitter—are driven synchronously by motors similar to the type used in washing machines. It is the duty of the disc at the receiver to rearrange the light impulses from the neon lamp into a pattern similar to that of the object at the broadcasting station. This is accomplished by making the disc revolve in exact synchronism with the scanning disc at the transmitter; thus, at each instant of the television operation, the beam of light that falls on the broadcast object at the transmitting end is being duplicated at the receiving end with a beam of light of exactly the same intensity, and directed at a corresponding point in space.

The result is that an exact image of the object broadcast is produced in the air in front of the disc. This image, which is in tones of red, due to the light given out by the neon lamp, appears at the approximate location shown in Figure 1. The picture appears in the form of a soft-focused photograph, and every movement by the person whose face is being broadcast is reproduced at the receiver. So sensitive are the photo-electric cells at the transmitter that even so intangible a thing as cigarette smoke reflects enough light to cause an exact reproduction to be seen at the receiver.

"Tuning" the picture in is especially interesting. First, the broadcast receiver is tuned to the wavelength of the transmitter, and then the operator, by means of a manually operated synchronizing resistance, changes the speed of his motor to the point where dim likenesses begin to appear in the frame of the receiver. There is a critical point of this adjustment at which the picture suddenly appears. Another few seconds are required for the operator to bring the picture perfectly into the frame, which is also a matter of synchronization. Once in the frame, the picture is maintained in position by manipulation of the resistance.

The present success of television has been due primarily to the invention of a single man, D. McFarlan Moore. It was back in 1906 that Mr. Moore first developed his neon lamp. At that time Mr. Moore made the then somewhat visionary prediction that this type of lamp would some day be used for television purposes. It was not until 1913 that he obtained enough of the rare

(Continued on page 168)

NEW "IMPEDANCE BALANCER" GIVES

More Pep for Phonograph Pick-ups

By ROBERT W. TAIT

THE popularity of the electrical pick-up unit and a low-frequency radio amplifier in connection with the rejuvenation of the old-style phonograph is growing by leaps and bounds. When the owners of these old phonographs find that they can get music comparable with the best that can be obtained from a high-priced radio receiver out of the new phonograph records by the simple addition of an amplifier and a radio reproducer, they are interested immediately. The next step is to choose the combination of apparatus that will be best suited to their particular needs.

In the six preceding issues of this magazine a number of methods for accomplishing these results have been described. This article describes a completely socket-power operated amplifier employing AC valves and push-pull amplification which, when hooked up to the lighting lines and the other apparatus shown in the combination diagram in Figure 1, gives a reproduction from the phonograph that is comparable to the original musical production in all its intricate tone quality. Furthermore, the volume obtainable is enough for any use up to that necessary for filling a large hall. Absolutely no batteries are required.

The amplifier is the AmerTran push-pull power-pack amplifier, the construction of which was fully described in detail in the January, 1927, issue of POPULAR RADIO.

In the diagram in Figure 1, at the left is shown the phonograph turn-table,

A new feature of extreme interest to those interested in the use of radio amplification apparatus in connection with phonograph pick-ups is the impedance balancer used in phonograph combination described in this article. This unit matches up the output impedance of the pick-up and the input impedance of the amplifier for the greatest transfer of energy at all musical frequencies. Its use with the power-operated AmerTran amplifier makes this combination unsurpassed as a quality musical reproducer.

which may be any old-style phonograph with a turn-table that revolves easily. On the arm of this phonograph is attached a Pacent electrical pick-up, which is connected by two wires to the volume control and in turn to the impedance equalizer which matches up the input impedance of the amplifier and the output impedance of the pick-up unit for the greatest transfer of energy at all musical frequencies. In the center is shown the push-pull amplifier with a balanced-tension loudspeaker at the right. A back view is shown of this

instrument. The connections between the instruments are shown in heavy black lines. If a console type of phonograph cabinet is used, all of the apparatus except the loudspeaker may be installed in the part of the phonograph compartment not being used for records. Another alternative is to install the amplifier in the portion of the phonograph cabinet previously occupied by the phonograph horn, which may be taken out, as it will not be used.

All that is necessary to place this combination of apparatus in operation is to insert the lamp cord on the AmerTran unit and plug into the 110-volt, 60-cycle AC socket and turn "on" the switch.

The amplifier uses one CY-227 type valves, two CX-310 type valves, and one CX-381 type rectifier valve.

The volume of the complete unit may be controlled from a whisper to a volume that is astonishing in its quality and power.

The unit may be used in the home for entertainment in place of an orchestra, or for dancing. It is also of sufficient power to be used in restaurants and other public places.

It is the highest type of combination of apparatus that it is possible to obtain for this purpose. A similar installation was made by the author in a well-known country club for furnishing music in the ballroom and it excited a great amount of interest and ability for itself, and since the day it was installed it has been used for entertainment almost continuously.

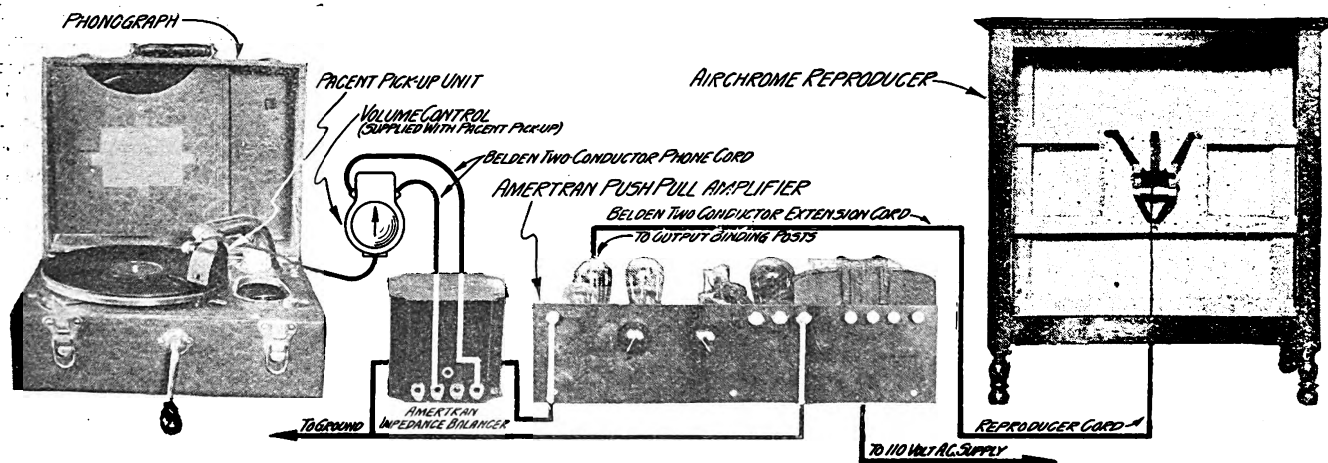
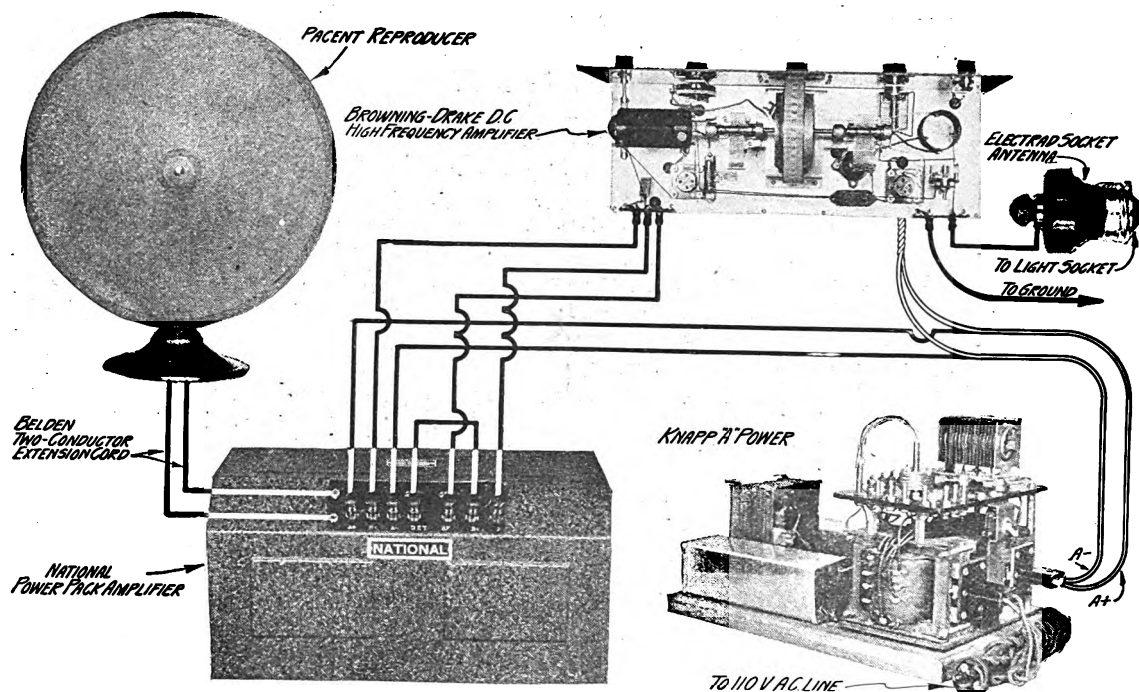


FIGURE 1: With the units shown above hooked up as indicated by the heavy black lines, phonograph music may be reproduced with a volume equal to that of an orchestra, and with a clarity and resonance that leaves nothing to be desired.



FOR GOOD RESULTS WITH THE DC BROWNING-DRAKE
 FIGURE 1: The hook-up combination shown above has been found very satisfactory in tests made in the POPULAR RADIO Laboratory, and is recommended to fans who want to get the best results out of the Browning-Drake tuner. Of course, radio users who live in localities where AC current is not available can substitute batteries for the Knapp "A" power unit, and use a good low-frequency amplifier with batteries instead of the National power-pack and amplifier shown above.

A Battery-Operated Browning-Drake

DC operation still has its ardent supporters, and the Browning-Drake tuner described in this article has been designed to make available to them the many excellent features of the 1928 Browning-Drake high-frequency pack. The foundation unit and most of the parts used in the AC model of the tuner are employed in the DC set, and the construction differs only slightly.

By GLENN BROWNING

THE 1928 Browning-Drake two-valve tuner was designed so as to be readily adaptable to either AC or DC operation, so that fans and set builders could easily install it with the type of wiring that was more convenient or desirable.

In the January, 1928, issue of POPULAR RADIO the tuner was described as used with AC valves. This article describes the construction of the set as used with DC valves.

It will be noted in the accompanying diagrams and illustrations that standard four-prong sockets are used in place of the five-prong sockets in the AC model. A rheostat has also been added in place of the original volume control. This rheostat should have a resistance of 30

ohms. Another addition is the fixed filament control for the two valves used as the high-frequency amplifier and the detector, respectively.

In constructing the DC two-valve tuner the general precautions already noted in the article on the AC tuner may be observed, with special reference to the changes shown in the top view of the set in Figure 2 and the picture wiring diagram in Figure 3. The set itself should be wired completely with a solid insulated bus bar, such as Celat-site, for connections running above the metal panel, and with rubber-covered Corwico hook-up wire for the connections below the metal panel. The two filament leads are to be brought out with two twisted, rubber-covered wires.

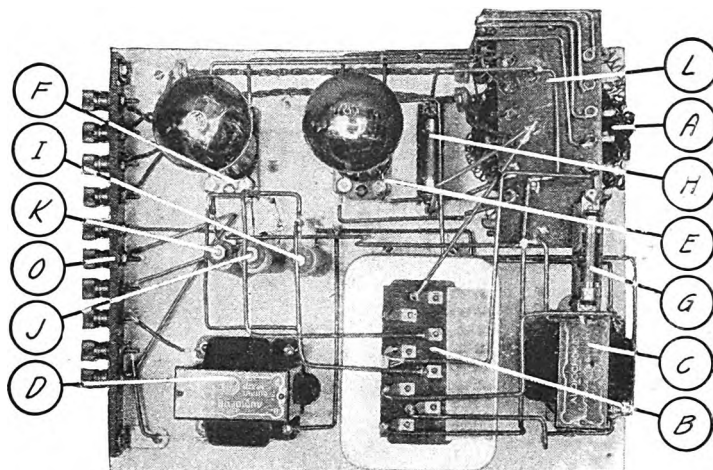
When the set has been finally wired up, according to the information given in Figure 3, it should be carefully checked over for possible error or for any omissions of wiring. After everything has been ascertained as correct, the set may be installed with any complete low-frequency amplifier that the builder desires to use with it.

The combination diagram in Figure 1 shows the set working with the National resistance-coupled power amplifier, which has been found to give exceptionally fine results when used with the DC tuner. In this combination all of the connections between the receiver and the amplifier are shown clearly, utilizing a Corwico battery cable for this

(Continued on page 149)

POPULAR RADIO WORK SHEET

THE DI. BLASI POWERIZER



THE MOUNTING OF THE PARTS

FIGURE 3: All of the instruments and parts are mounted above the baseboard in the positions shown above. Note how few instruments are required, and how simple their arrangement is on the baseboard.

LIST OF PARTS USED IN BUILDING THIS UNIT

COST OF PARTS—Not over \$63.00

A—Radio Receptor power transformer, type No. KXY-210, equipped with terminal board, L;

B—Dubilier condenser bank, type PL-730, total of 10 mfd.;

C—Pacnet audiochoke, No. 29;

D—Pacnet output transformer, No. 27-B, 1 to 1 ratio;

E and F—Pacnet UX sockets, No. 83;

G—Lynch suppressor and mounting, 1,600 ohms;

H—Lynch suppressor and mounting, 700 ohms;

I and K—Lynch power resistors, 8,000 ohms;

J—Lynch power resistor, 10,000 ohms;

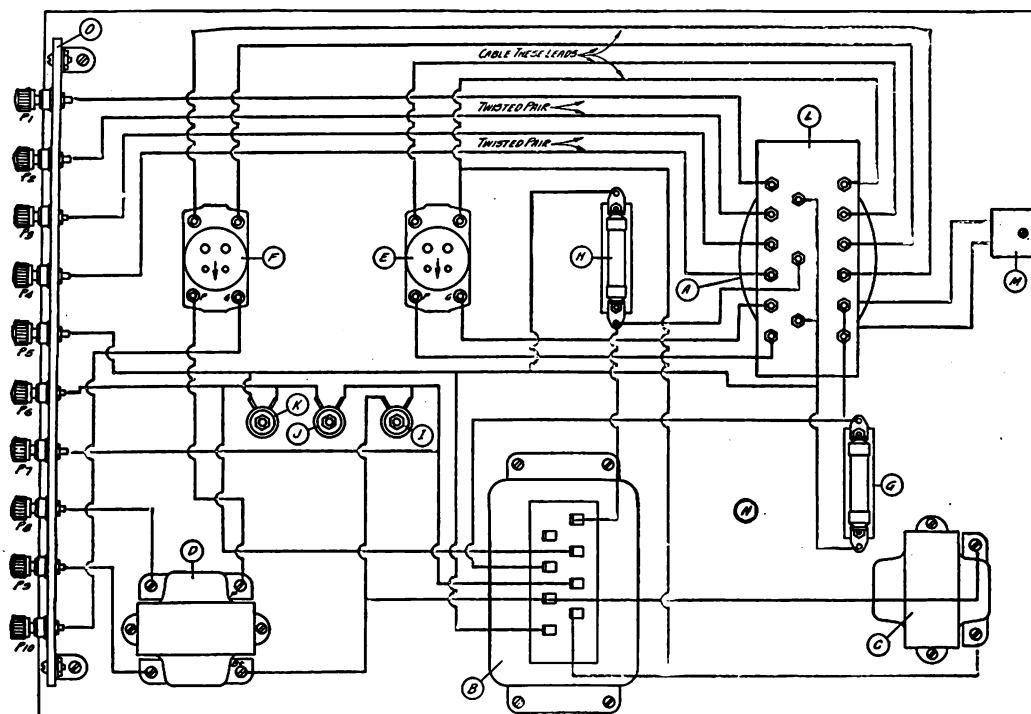
M—Separable attachment plug;

N—Wooden baseboard, 10 by 12 by ½ inch;

O—Formica binding-post strip, 9 by 1 by ¼ inch;

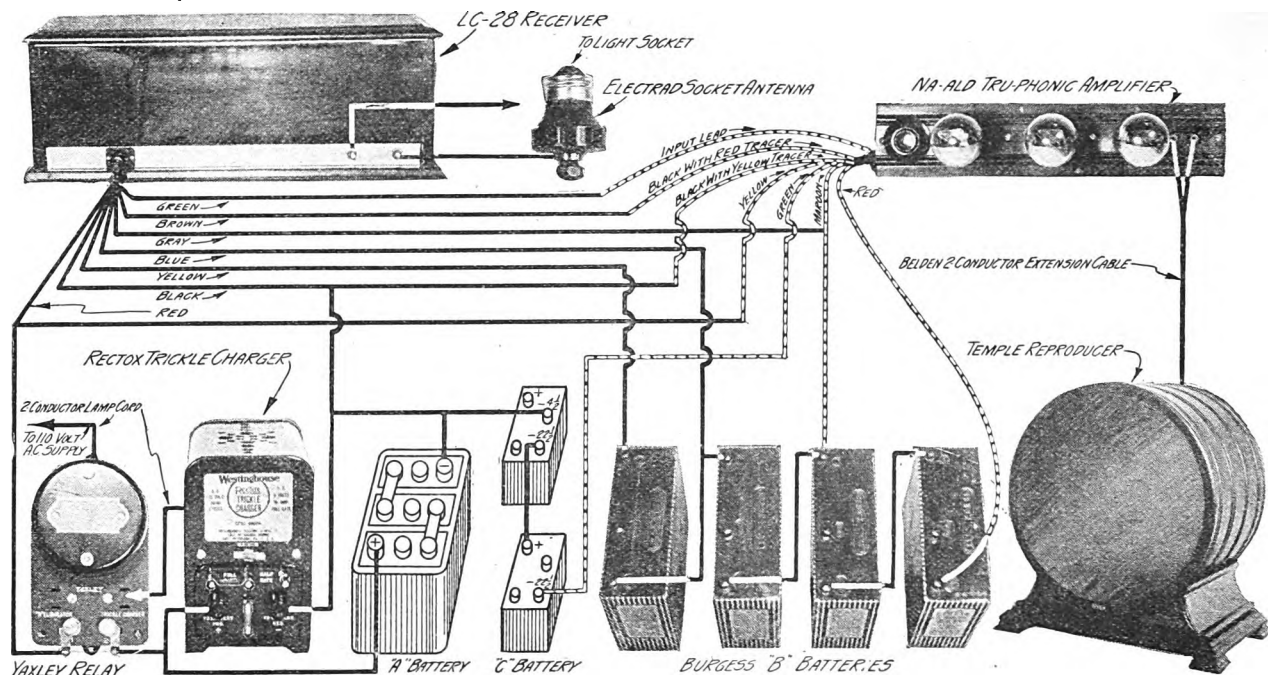
P1, P2, P3, P4, P5, P6, P7, P8, P9 and P10—Eby binding posts;

20 feet of Corwico Braidite.



THE WIRING OF THE POWERIZER

FIGURE 4: All the wiring is done above the baseboard, and is shown here in heavy RED lines. The wiring is greatly simplified by the fact that the transformer, A, comes with all its leads brought out neatly to a terminal board, L.



A COMPACT HOOK-UP THAT GIVES EXCELLENT RESULTS

FIGURE 1: In the hook-up shown above, which has been tested in POPULAR RADIO Laboratory and found to give very fine results, all the operating voltages are drawn from batteries. The small size of the Na-ald Tru-Phonic amplifier makes this hook-up a very practical one where a limited cabinet space is available.

Flawless Amplification for the LC-28

Absolutely humless reproduction, easy control of voltages, low initial cost—these are a few of the many advantages of battery operation of receivers. And the two amplifier hook-ups for the LC-28 described in this article have all these virtues that come from battery operation, and in addition both combinations are extremely compact, efficient and easy to install and operate.

By LAURENCE M. COCKADAY

EVEN in these days of extraordinary enthusiasm for complete AC operation of radio receivers there are still a goodly number of conservative fans who believe that battery operation still affords the most satisfactory solution of their radio power problems.

Some of the theoretical reasons for this preference of radio fans are the following:

(1) Batteries can produce no hums or extraneous noises.

(2) A battery installation can be made entirely separate from the alternating current line and the probable chance of inductive hums in nearby circuits is greatly reduced.

(3) Batteries give constant and uninterrupted source of voltage during their useful life.

(4) Battery voltages are not subject to interruption of service due to electric or wind storms or other outside

causes that are beyond man's control.

(5) Batteries may be tapped to obtain the exact voltages necessary for any particular work.

(6) Batteries of varying ratings may be used to furnish power economically for circuits of varying power conditions.

These points of consideration are frequently little understood by radio users. It is a fact, however, that quality radio reception can be obtained with the least expense of engineering skill, with the least expense of money and with the use of much less complicated circuits, when batteries are employed as a power supply.

Of course, AC-operated apparatus has its definite advantages, although it entails much greater intricacies of circuit design and, in most cases, a higher initial cost for the apparatus.

As stated before, there is a definite

field and use for both storage batteries and dry cell batteries in radio that will always exist and that can be filled by no other devices or combinations of apparatus.

There are also those who live in outlying districts where the necessary alternating current is not available, who must rely on batteries for their set operation. There are, therefore, many thousands of radio set owners in these categories who will be interested in the two new DC-operated amplifier units described in this article. These are the fourth and fifth amplifiers to be described as suited for operation with the LC-28 high-frequency pack. Those who have built the LC-28 receiver and must rely on DC operation will find in either one of these power amplifiers an economical and wholly satisfactory unit for quality reproduction at adequate volume for all home needs.

The first of the two units to be described is the new Truphonic power amplifier. This unit consists of three stages of the now famous Na-ald Truphonic amplification incorporated in a small, neat metal container, equipped with a filament control and an extension cable for all connections.

The complete hook-up for the Truphonic amplifier, with all of the recommended accessory apparatus and the LC-28 high-frequency pack, is shown pictorially in the combination diagram in Figure 1. In this diagram the Truphonic amplifier is shown in the upper right-hand corner, with the Temple exponential horn reproducer connected to the two output binding posts. It is advisable, in an installation of this kind, to use an extension cord for the reproducer and place it on the opposite side of the room from the set.

In the lower portion of this same diagram are shown the necessary batteries required, with a Yaxley relay and a Rectox trickle charger for keeping the "A" battery fully charged at all times. The relay and the trickle charger, of course, are used only where a 110-volt AC supply is available. In the upper left-hand corner is a rear view of the Corbett cabinet, with the Yaxley cable connected in place and the antenna and ground connections made to the two small tip jacks.

An Electrad socket antenna is recommended, although a regular outdoor antenna may be used, if so desired. All of the connections between the units are clearly indicated. The dotted lines

show the connections to the cable of the Truphonic amplifier. All of the equipment, except the set and the socket antenna, may be installed in a radio table compartment, with the set arranged on top of the table; or, if preferred, a regular Corbett console may be used. These two types of cabinets are made expressly for the LC-28 receivers.

When all of the apparatus has been installed, insert two Tele vocal TC-201-a type valves in the first two sockets, at the left in Figure 1. Insert a TC-171-a type valve in the right-hand socket.

The tuning of the set will be exactly as explained in the article in the October, 1927, issue, and the set will turn "on" and "off" with the switch-rheostat on the face of the panel.

The set will give all of the volume that is necessary for home reproduction and the quality will be exquisite on both high and low tones, as the combination of the Temple reproducer and the Truphonic amplifier produces an extremely even tone range.

The Second Combination

The second unit that will be described is intended for the special benefit of radio fans who are interested in double-impedance amplification. This unit is the Harkness amplifier, incorporating two stages of double-impedance amplification followed by one stage of double-impedance, push-pull amplification; this last is a recent development. This unit may be obtained complete, as shown in

the lower right-hand corner of the combination diagram in Figure 2. The diagram gives the proper connections for the LC-28 high-frequency pack and the new push-pull amplifier. It also shows the connections for the "A," "B" and "C" batteries and for a Yaxley relay and trickle charger for automatic charging of the "A" battery.

For the best results the new Pacent cone reproducer is recommended for this amplifier and its proper connection is indicated. The dotted lines in the wiring indicate the wires of the cable with which the push-pull amplifier is equipped, while the black lines indicate the connections of the Yaxley cable, which is part of the equipment of the LC-28 receiver.

As in the previous case, an Electrad socket antenna is recommended and should give excellent results without bothering about an outdoor antenna. A standard outdoor antenna may be used, however, if so desired.

The vacuum valves for this receiver are two Tele vocal TC-201-a type valves placed in the two sockets on the left, as shown in Figure 2, and two TC-112 type valves in other sockets.

This amplifier and reproducer, in combination, produce excellent tone quality and volume, particularly on the low notes, as the new Harkness tuned units are incorporated in the amplifier. The two 112-type valves are used in "push-pull" arrangement and thus produce the necessary volume without overloading, with the utmost conservation of the life of the "B" batteries.

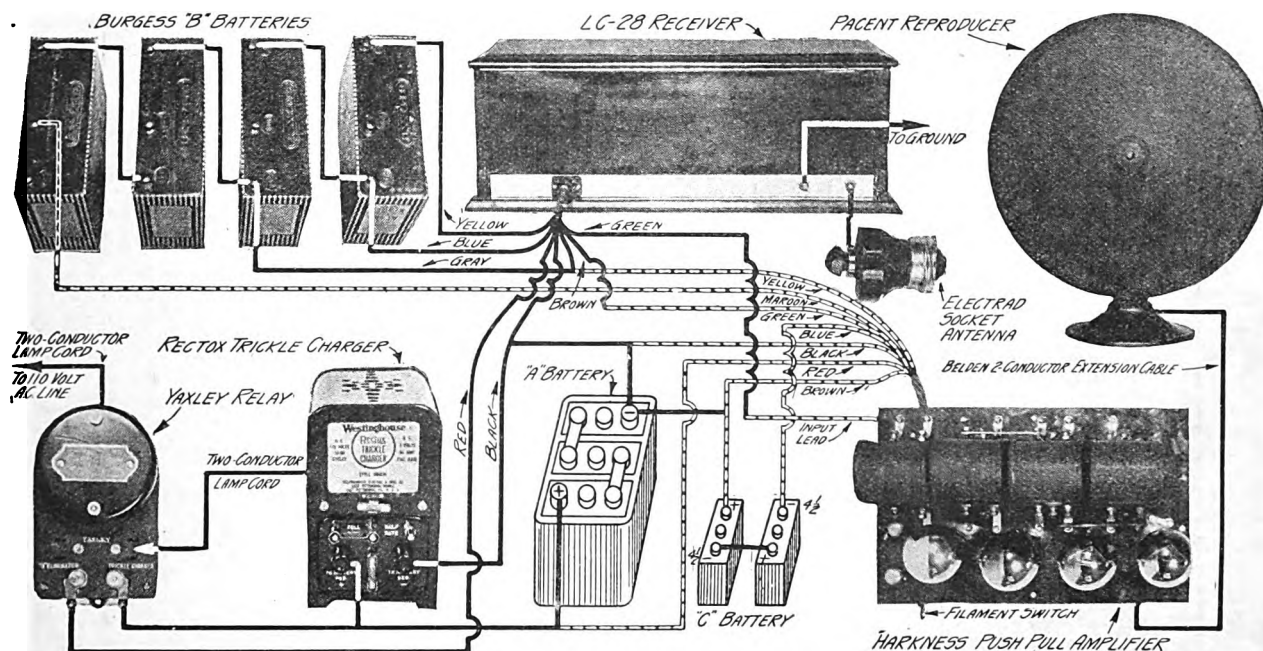


FIGURE 2: The Harkness amplifier, shown at the lower right, has been found to handle the detector output of the LC-28 with exceptional power and fidelity. It employs double-impedance and push-pull (last stage) coupling. The operating voltages may be taken from batteries, thus insuring absolutely humless reproduction.

POPULAR RADIO WORK SHEET

THE GENERAL RADIO PUSH-PULL AMPLIFIER AND POWER-PACK

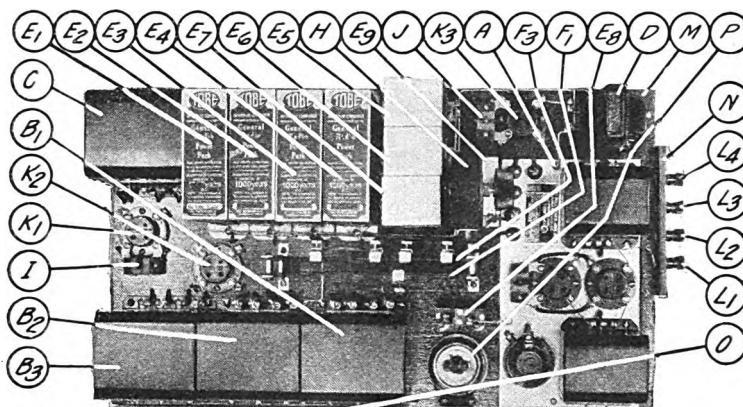


FIGURE 1: THE PANEL LAYOUT OF THE UNIT.

LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$113.00

- | | | |
|--|--|---|
| <p>A—General Radio push-pull amplifier, type 441, completely wired and mounted on metal chassis;</p> <p>B1, B2 and B3—General Radio power transformers, type No. 365;</p> <p>C—General Radio filter choke, type No. 366;</p> <p>D—General Radio low-frequency transformer, type No. 285-D;</p> <p>E1—Tobe special high-voltage condenser for G. R. power-pack, No. 1102, 2 mfd.;</p> | <p>E2, E3 and E4—Tobe special high-voltage condenser, No. 604, 4 mfd.;</p> <p>E5, E6 and E7—Tobe special high-voltage condensers, No. 601, 1 mfd.;</p> <p>E8 and E9—Tobe by-pass condensers, 1 mfd.;</p> <p>F1 and F2—General Radio, type 446, resistance units mounted together;</p> <p>G—General Radio resistance strip, 6 ohms, for 1 ampere;</p> <p>H—General Radio variable resistor, 2,000 ohms, with bracket;</p> | <p>I and J—General Radio center-tapped resistors, type 439;</p> <p>K1, K2 and K3—General Radio 4-prong sockets, type 349;</p> <p>L1, L2, L3 and L4—Eby binding posts;</p> <p>M—Wooden baseboard, 12 by 20 by 3/4 inch;</p> <p>N—Formica binding-post strip, 2 by 5 by 3/16 inch;</p> <p>O—Formica protection panel, 2 1/2 by 10 3/4 by 3/16 inch;</p> <p>P—G. E. snap switch.</p> |
|--|--|---|

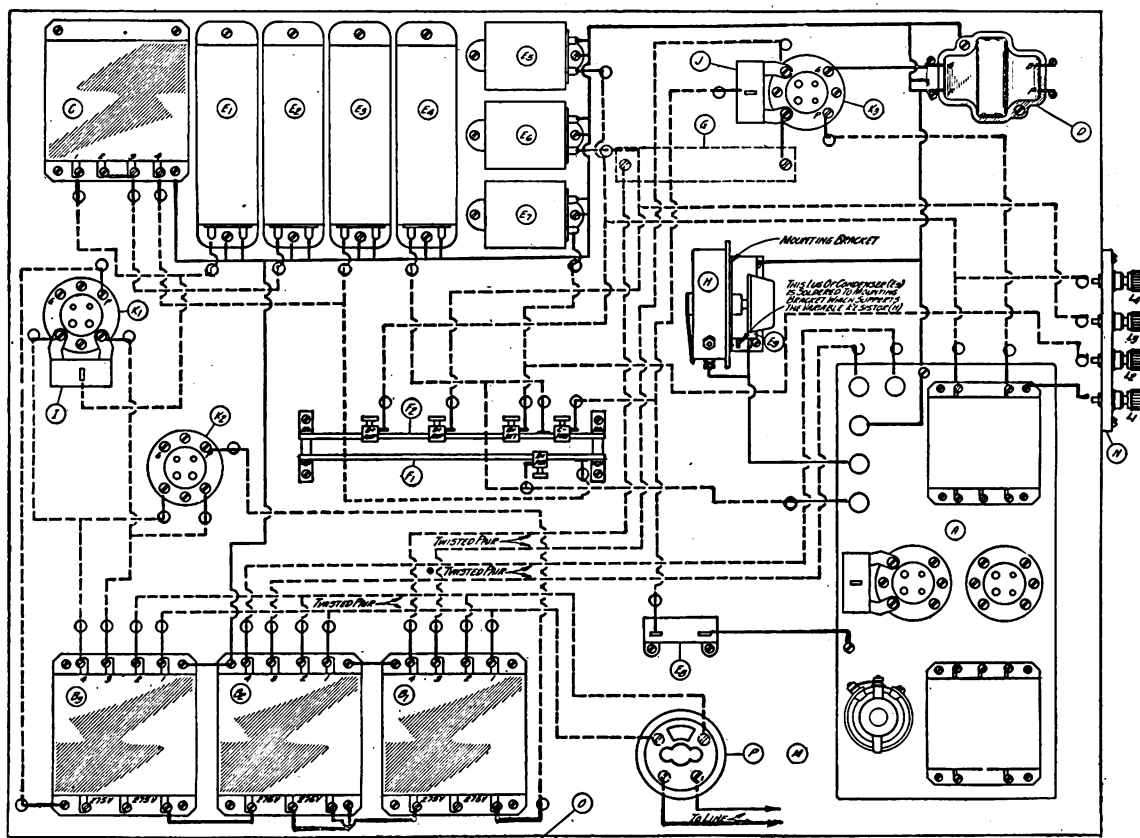
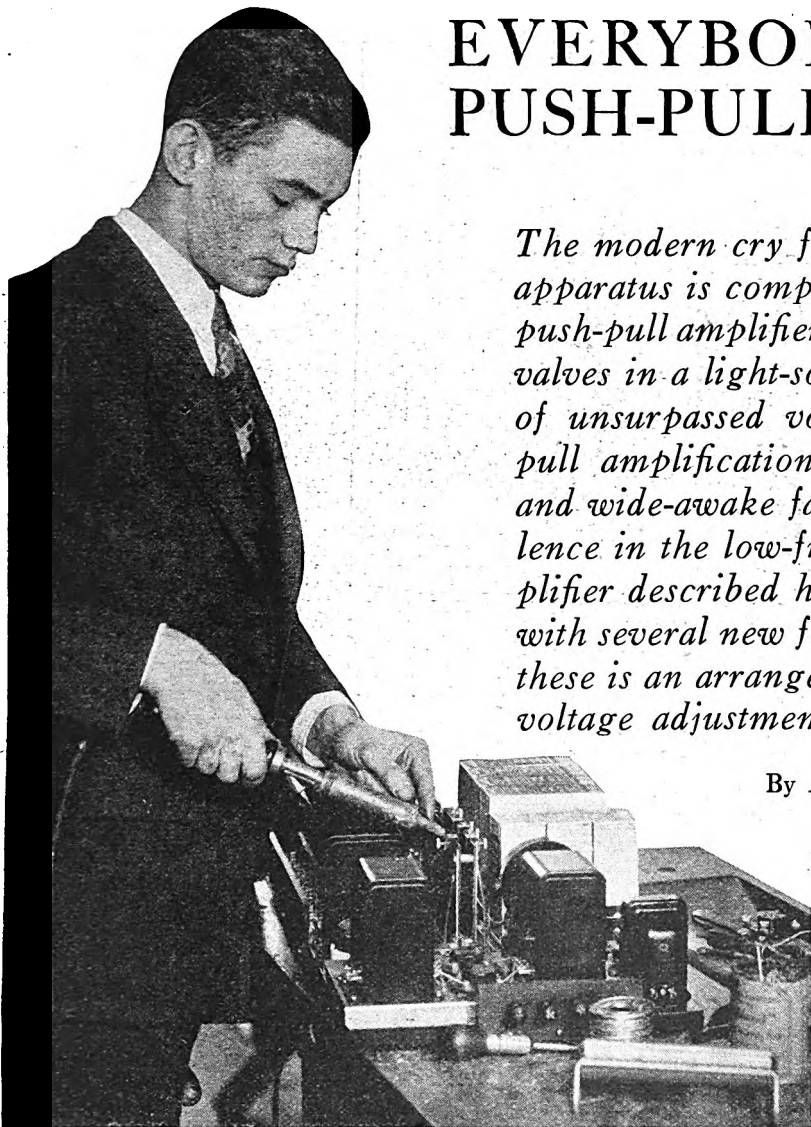


FIGURE 2: THE PICTURE WIRING DIAGRAM OF THE UNIT.

EVERYBODY WANTS A PUSH-PULL AMPLIFIER!



The modern cry for power in low-frequency apparatus is completely satisfied in this latest push-pull amplifier, employing 310 type power valves in a light-socket-operated combination of unsurpassed volume and quality. Push-pull amplification is admitted by engineers and wide-awake fans to be the acme of excellence in the low-frequency field, and the amplifier described here combines all its virtues with several new features of its own. Among these is an arrangement for providing a plate voltage adjustment over a very wide range.

By A. R. WILSON

the flexibility and reserve which makes the more powerful car desirable. This idea applies also to radio reproduction. With the 310 type of valve the receiver is literally loafing along, even when great volume is being used.

The General Radio power-pack amplifier described here is a complete two-stage, AC-operated amplifier, adaptable for use following the output of a radio detector circuit or with a phonograph magnetic pick-up. In addition it will supply all the "B" voltages necessary for the set with which it is to be used. It uses transformer-coupling with a CX-326 type valve in the first stage and two 310 type valves in the last stage connected in push-pull arrangement. The rectifier system has been designed to furnish approximately 750 volts when two CX-381 rectifying valves are employed.

The voltages placed on the plates of the two 310 type valves have been made adjustable over a wide range, as it is felt that the common practice of connecting the plate of the last stage power valve directly to the high-voltage side of the rectifying system is not in keeping with the maximum efficiency. In similar devices the grid voltage for the last valve is usually obtained by the voltage drop through a resistance placed in the grid return. This resistance is usually variable and any adjust-

(Continued on page 148)

FOR those people who demand the most perfect radio reproduction, a power amplifier is a necessity. A power amplifier is not intended primarily to increase the volume of a set, but rather to make use of amplifying valves capable of many hundred times the power delivery of the ordinary standard type. When a large amount of energy is delivered to the reproducer, low notes and overtones, which heretofore have been either inaudible or distorted, are heard with remarkable fidelity.

Prior to the input of the last amplifying valve, we are concerned in securing a voltage amplification gain, but at the end of the amplifier we have a device, our reproducer, which requires real physical energy to operate it satisfactorily. Hence the use of power valves is necessary for the most successful operation of a reproducer.

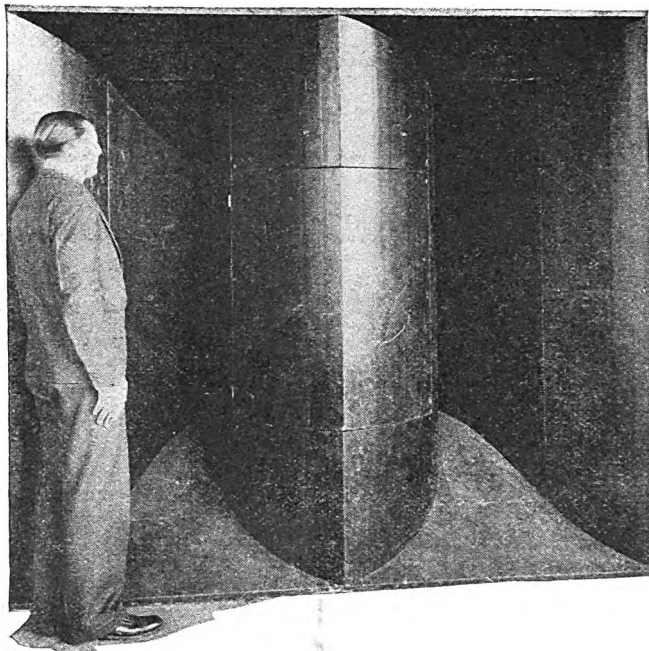
The introduction of the CX-310 type power valve has meant much in the advancement of quality reproduction. When this type of valve is used in a

push-pull system, which has the advantage of minimizing or eliminating most of the harmonic distortion caused by the valves themselves, the reproduction becomes almost perfect. The push-pull system also has the advantage of increasing the power output four or five times. To a certain extent, the greater the power output the better the quality. With proper power, an unusual *fortissimo* passage in reproduction finds the vacuum valves handling it with ease, just as a good high-powered automobile takes a hill without diminution of speed. There is enough energy to give the bass notes the proper color and intensity with a factor of safety to spare.

Why all this power? Let us draw an analogy. Today there is less and less opportunity for fast driving on the public highways—yet greater power is a feature of all new motor cars. It is much more comfortable to drive a seventy-mile-an-hour car at thirty-five miles an hour than to drive a fifty-mile-an-hour car at the same speed. It is

THE MOUTH THAT MADE THE "ECHO" AUDIBLE

At the right is the huge 8-foot orthophonic horn by means of which the radio "echo" of Lindbergh's voice was made clear and distinct to the 5,000 people who had gathered to hear him speak.



A Radio "Echo" That 5,000 Heard

By J. R. JACKSON

NEARLY every radio fan has at some time heard Colonel Charles A. Lindbergh broadcast, or has heard his phonograph records, which were recorded from a radio broadcast. But seldom, if ever, has Colonel Lindbergh himself been afforded so unique an opportunity to hear his own voice on the radio, as he was during his reception last fall in Atlantic City.

Colonel Lindbergh flew to the Atlantic City Municipal Airport from Baltimore, Md., in his famous ship, the *Spirit of St. Louis*. He circled over the field several times, and then made a perfect landing several hundred feet from the speakers' stand. He was

taken to the airport club house, where the speakers' stand was arranged on the balcony.

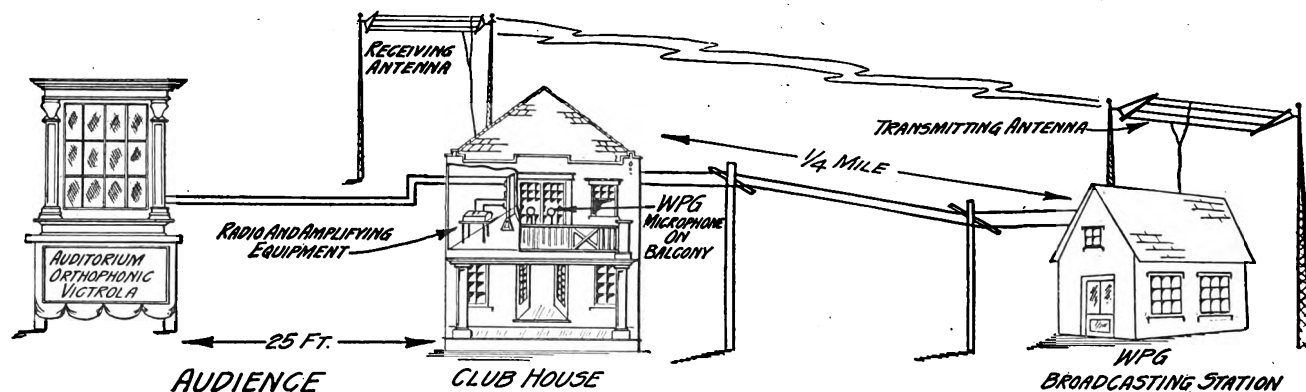
Station WPG broadcast the Lindbergh reception to thousands of listeners within receiving range of this station. Colonel Lindbergh himself and the great throng of people whom he was addressing were a part of this radio audience. A radio receiving set operating in conjunction with the amplifying and reproducing equipment of a giant Auditorium Orthophonic Victrola was located but a few feet from the speakers' stand. The radio broadcast was received, amplified and reproduced in this super-loudspeaker with

such great volume and clarity that it could be heard by all of the audience of 5,000 people.

Such a demonstration as this has proved another of the great possibilities in radio broadcasting. The engineers of the Victor Talking Machine Company, working with station WPG, have accomplished something which would have seemed quite impossible a few years ago—the production of tremendous radio loudspeaker volume without any trace of distortion, overloading or interference.

The microphones of station WPG were located on the speakers' stand im-

(Continued on page 171)



HOW THE "ECHO" WAS PRODUCED

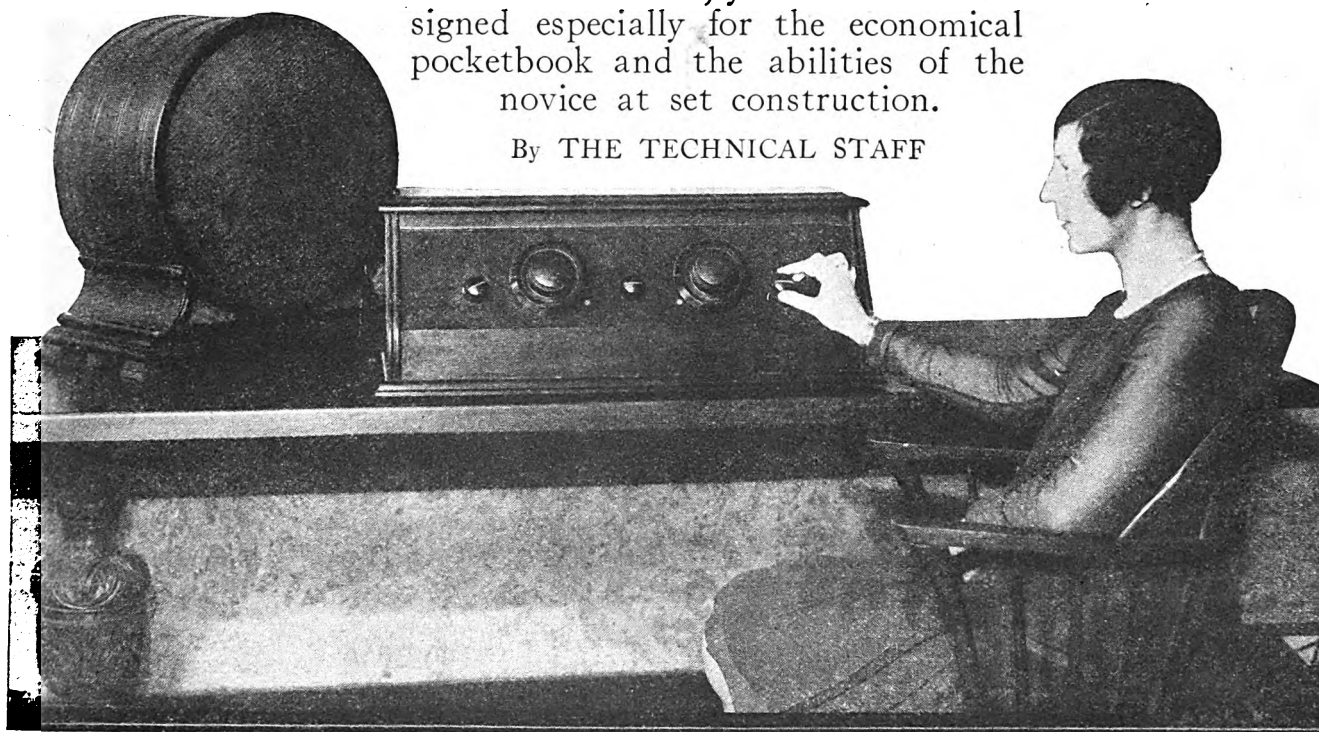
Colonel Lindbergh stood on the balcony of the club house in the center and spoke into the microphone before him. His voice was carried by wire to station WPG and broadcast. It was picked up by a receiving set in the club house, amplified and reproduced with the aid of the giant orthophonic horn at the left, so that the 5,000 people gathered in front of the club house could hear distinctly every word that Lindbergh uttered.

IF YOU ARE LOOKING FOR QUALITY *AND* ECONOMY

Build the Hammarlund-Lynch "5"

Here is a receiver whose appearance and operation place it among the best that can be built, yet it has been designed especially for the economical pocketbook and the abilities of the novice at set construction.

By THE TECHNICAL STAFF



THERE are many people who would like to build radio sets, but who, as beginners, feel a bit timid in attempting to assemble one of the more complicated receivers involving expensive parts. A fear of costly failure deters them. For this particular reason POPULAR RADIO has brought out a receiver that might well act as a confidence-builder. Those beginners who decide to construct it can do so with the feeling that success will be assured, and that there is actually little prospect of failure. The parts needed are of good quality, though inexpensive, and the number of connections to be made have been reduced to an absolute minimum.

Though the receiver described here is primarily a "novice job," from the point of view of easy constructibility and operation, it is nevertheless a very efficient set, with excellent tone quality and sufficient sensitivity and selectivity to provide reception without interference from a large number of stations. It consists, essentially, of a "deck" or sub-panel upon which are mounted three stages of efficient resistance-coupled amplification. This deck may be obtained completely assembled, with the various resistors,

sockets, capacities and a large part of the wiring already completed. The cost of this unit is low, although nothing has been spared in making it an efficient amplifier. Also, the front panel, upon which are to be mounted two variable condensers, a coil and two rheostats, may be obtained already drilled and engraved.

The entire assembly can be done with a screw driver. As to wiring up, the job is extremely simple. A glance at the picture wiring diagram in Figure 3 will bear out the statement.

A completed receiver, installed in the slanting-panel cabinet of the LC-28 type, gives a finished appearance that cannot be outdone by many receivers costing four to five times the amount that is necessary to build the Hammarlund-Lynch "Five."

How to Assemble the Set

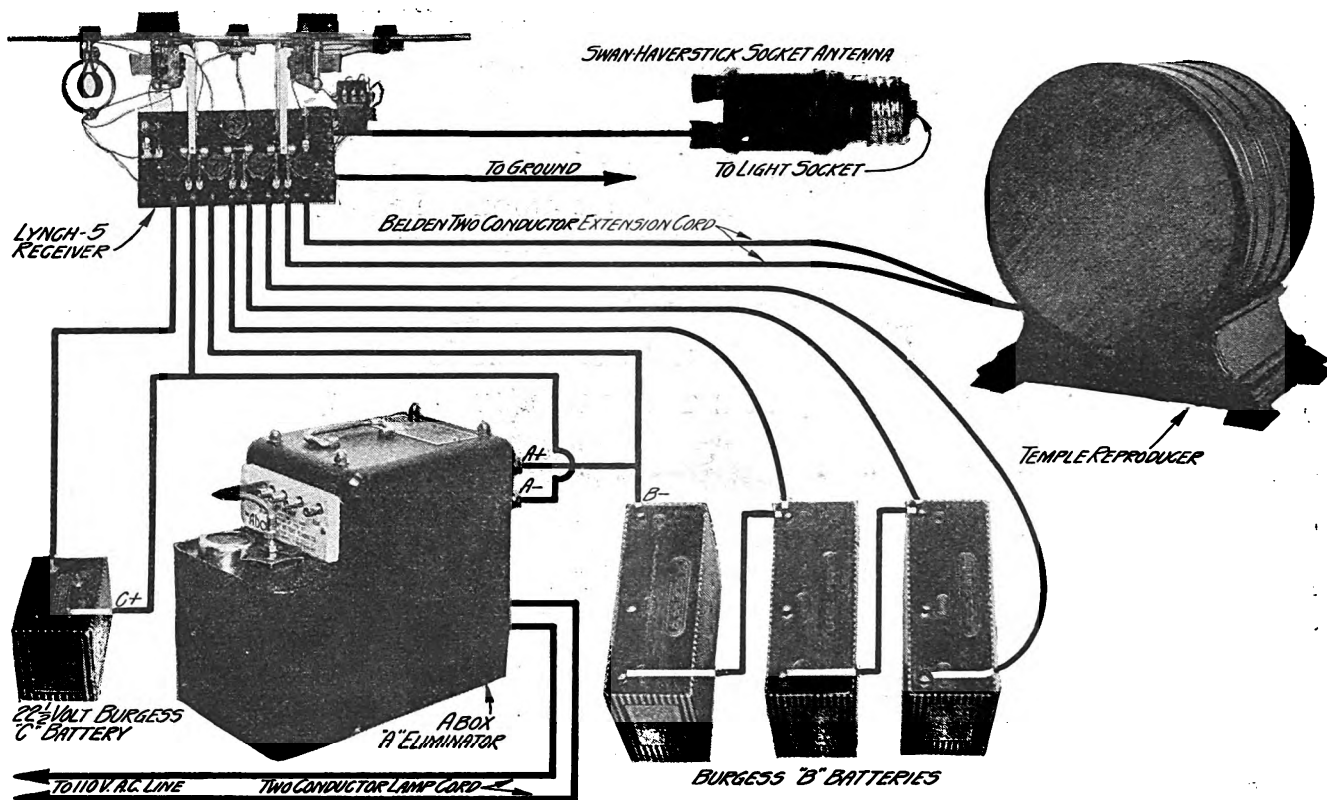
The first job to be undertaken in putting this efficient receiver together is to mount the 12 binding posts, K1 to K12, along two sides of the deck, E, in the holes already drilled for them. Then the Lynch suppressor and mounting, H, is screwed down to the panel of the deck. These two locations are

shown clearly in the diagram in Figure 2.

Next fasten down the two small semi-circular fixtures of the brackets, M1 and M2, as shown in the same illustration. Then fasten the antenna coupler, A, to the left-hand edge of the deck, in the corner hole. These positions are also indicated in Figure 2.

Now begin with the mounting work on the panel by mounting the two variable condensers, C and D, and the coupler-coil, B. The two rheostats, F and G, should then be mounted on the front panel. The large sections of the brackets, M1 and M2, should then be screwed to the panel by two screws to each bracket and fastened by two more nuts and bolts to the semi-circular portions mounted on the deck, E. These should be tightened only partially and the set should be inserted in the Corbett LC-28 cabinet for the correct positions before the brackets are fastened tightly. When the panel is in place, the deck should lie flush along the floor of the cabinet. The four nuts and bolts may then be tightened up on the brackets so that this position will be maintained.

This completes the assembly of the receiver, and wiring may be started.



FOR EFFICIENT OPERATION OF THE HAMMARLUND-LYNCH "5"

FIGURE 1: The accessories shown above form an inexpensive and easily assembled operating hook-up for the receiver. The use of a socket antenna eliminates the bother of erecting an outdoor antenna system; however, an outdoor antenna will give very satisfactory results with the hook-up shown here.

How to Wire the Receiver

The wiring of this simple set, which employs one stage of high-frequency amplification and an efficient regenerative detector, followed by three stages of resistance-coupled amplification, is shown in exact layout in the picture wiring diagram in Figure 3.

It is recommended that Corwico Braidite hook-up wire be used in doing the wiring. With this wire, connections are extremely easy, as the proper lengths may be cut and the insulation merely pushed back for making a soldered joint.

Follow out carefully each connection shown in the picture wiring diagram and there will be no possibility of mistake.

After the wiring has been completed, check it over to be sure that everything is correctly done. Then the set may be placed in its Corbett LC-28 cabinet and it is ready for operation.

How to Operate the Receiver

The set in its cabinet may be placed on a table and the batteries arranged beneath and hooked up in the manner shown in the combination diagram in Figure 1. This diagram shows the various apparatus that is recommended for use with the Hammarlund-Lynch

"5," and it also indicates exactly how the necessary hook-up wires are to be connected.

The set may be used with a light socket antenna, if so desired, but a regular outdoor antenna may, of course, be connected, for greater volume and distance. The Temple reproducer should be installed on the opposite side of the room, and for this purpose it would be advisable to use a Belden extension reproducer cord.

The vacuum valves recommended for this receiver are a Ceco type K high-frequency amplifier valve that is to be inserted in the high-frequency socket. This is the socket that is nearest the panel when the reader is looking at the set from the front. A Ceco type H special detector valve should be inserted in the first socket at the right. Two Ceco Hi-Mu valves should be placed in the two middle sockets in the row, and a Ceco type F power valve should be inserted in the socket on the left.

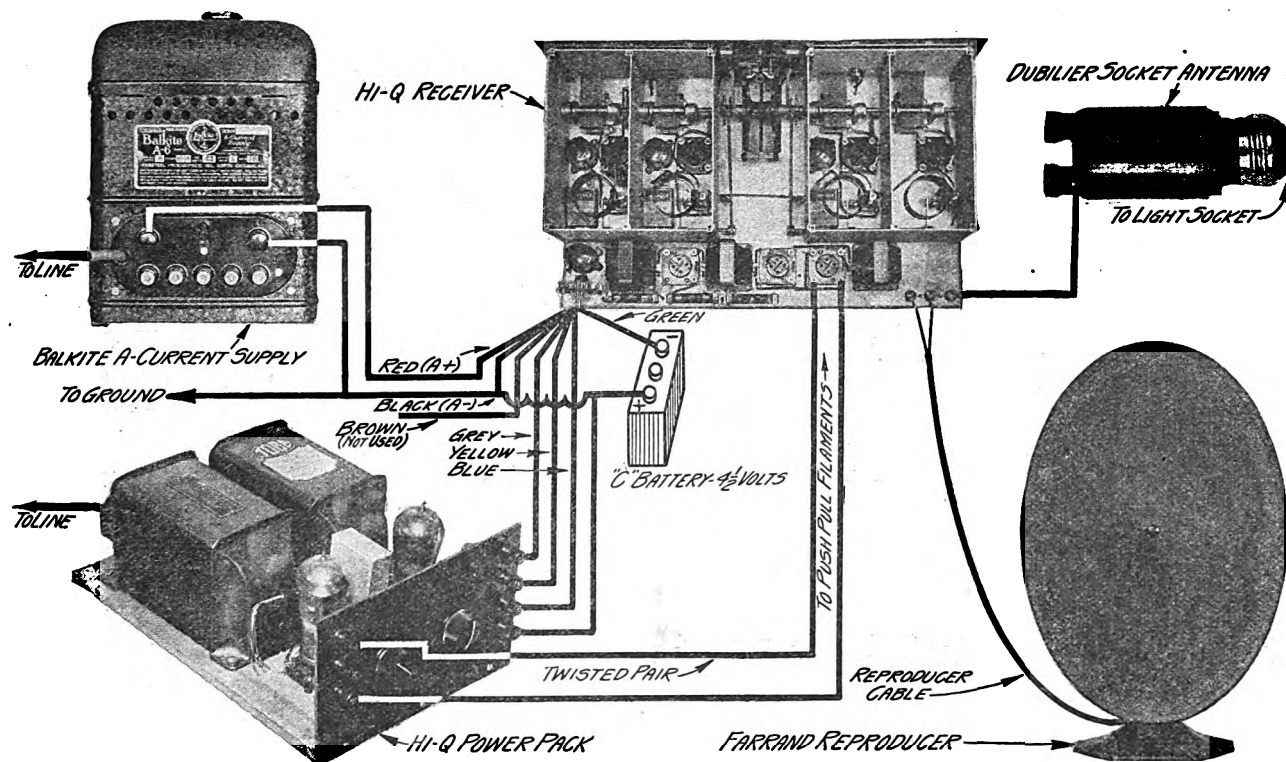
When all of the connections have been made to the batteries, the exponential horn reproducer and the antenna and ground, the set is ready for use.

To turn "on" the receiver, the middle switch on the rheostat, G, should be rotated in a clockwise direction for

about three-quarters of the way. The same should be done with the rheostat, F. All of the vacuum valves should then light up and the two dials on the condensers, C and D, may then be rotated until a station is tuned in. If the set whistles, the rheostat, F, control knob should be turned in an anti-clockwise direction and the knob of the coil, B, controlling amplification in the detector circuit, should also be revolved slowly in an anti-clockwise direction until just the right setting is obtained, where the amplification is maximum without oscillation.

In using the receiver for the first time, it is advisable to make a tuning chart, setting down the call letters of each station and the dial settings for the two main dials and for the two outside small controls. The small middle control on the panel may be left set where the tone quality is found to be best.

In tests on this inexpensive receiver in New York City it was found that it operated with satisfactory selectivity for tuning in without interference and with a tone quality that was really pleasing to listen to. Both in appearance and in consideration of the results obtained, the new receiver is exceptional for the amount of money it costs.



A POWER HOOK-UP FOR THE IMPROVED HI-Q

FIGURE 1: With the addition of a final stage of push-pull amplification in the Hi-Q "Six," the receiver makes greater demands on the power supplying apparatus than the older model; and the operating combination shown above is planned to take care of this need. The No. 713 power block of the Hi-Q "B" power-pack, whose construction was described in the January number of POPULAR RADIO, must be replaced with a No. 718 power block, in order to supply the proper voltages for the push-pull stage.

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PUT MORE SNAP IN YOUR RECEPTION BY INSTALLING PUSH-PULL for the HI-Q

With push-pull amplification coming into favor more and more each month, fans who own the new Hi-Q's will want to add this feature to their receivers. The necessary changes may be made in a very short time, and the addition of the powerful push-pull stage will make the Hi-Q a receiver of unsurpassed quality.

By LESLIE BILES

SINCE January, 1924, when the principles of push-pull amplification were first made available to the radio public, receiver design has improved to an almost unbelievable extent. However, the design of push-pull has kept abreast of general radio progress, and today it is judged by increasingly larger numbers of experts and fans as the premier method for the last stage of low-frequency amplification.

In a splendidly designed receiver such as the Hi-Q, the use of modern push-pull amplification may be expected to give an added power and truthfulness of

reproduction that is well worth trying.

This article shows exactly how to incorporate push-pull in the Hi-Q "Six," and to operate it with the official Hi-Q power-pack. A change is necessary in the Hi-Q power-pack, in that the Samson power block No. 718 is to be substituted in place of the regular block type No. 713. All the other parts and the wiring remain the same, however. The Hi-Q "Six" receiver construction was given completely in the November, 1927, issue of POPULAR RADIO, and the construction of the Hi-Q "Six" power-pack was given in January, 1928.

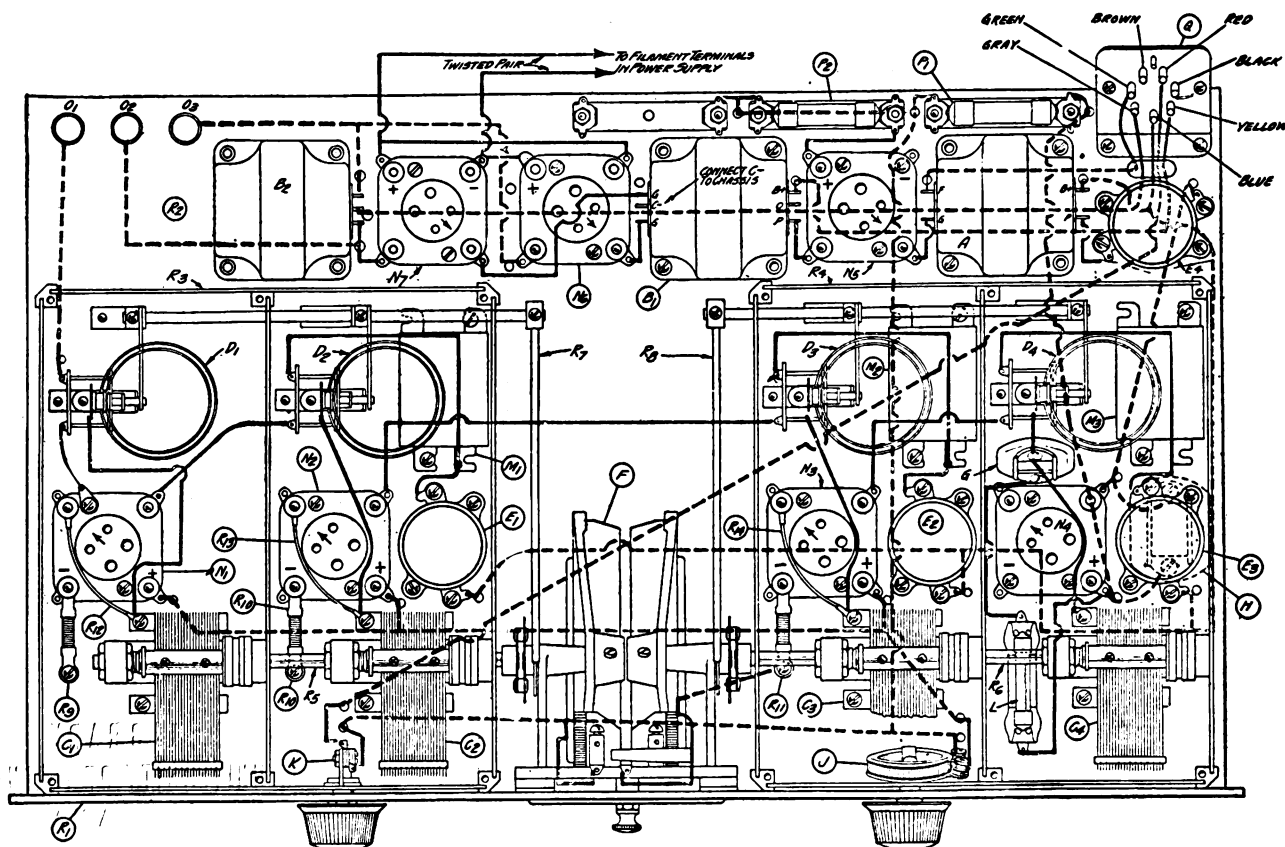
The Changes Necessary to Be Made in the Hi-Q "Six"

The picture wiring diagram in Figure 2 and the illustration in Figure 3 show the addition of an extra socket, N7, and the substitution of a Samson input push-pull transformer, B1, for the original transformer, B. These illustrations also show the addition of an output push-pull impedance, B2. The amperite, B3, is not used.

This, of course, will necessitate changes in the wiring. The completely wired instrument, with the changes, should conform to the picture wiring

POPULAR RADIO WORK SHEET

THE HI-Q "SIX" WITH PUSH-PULL AMPLIFICATION



THE WIRING OF THE IMPROVED RECEIVER

FIGURE 2: The wiring of the Hi-Q "Six" with push-pull amplification is shown above in solid red lines, where it runs above the sub-panel, and in dotted red lines where it runs below the sub-panel. The instruments are outlined in black. Condenser H, shown in dotted black lines, is mounted under the sub-panel. A comparison of this diagram with that on page 315 of the November number of POPULAR RADIO, which gives the wiring of the standard Hi-Q "Six," will show how few and simple are the changes necessary for incorporating push-pull amplification in the receiver. The wiring of the high-frequency amplifier and detector remains the same; the last-stage low-frequency transformer of the old model is replaced by the push-pull input transformer, B1; the output push-pull transformer, B2, and an extra valve socket, N7, are added to the layout, and the wiring of the low-frequency amplifier made as shown above.

LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$110.00

A—Samson symphonic transformer;
B1—Samson push-pull transformer, type Y;
B2—Samson output impedance, type Z;
C1, C2, C3 and C4—Hammarlund mid-line variable condensers, .0005 mfd.;
D1, D2, D3 and D4—Hammarlund auto-couple coils, HQ-64;
E1, E2, E3 and E4—Hammarlund chokes, type RFC-85;
F—Hammarlund illuminated drum dial;
G—Sangamo mica fixed condenser, .00025 mfd.;
H—Sangamo mica fixed condenser, .001 mfd.;
I—Sangamo grid-leak clips;
J—Carter Imp rheostat, 6 ohms, type 1-R-6;

K—Carter Imp battery switch, type 2-A;
L—Durham metallized resistor, 2 meg-ohms;
M1, M2 and M3—Acme Parvolt bypass condensers, .5 mfd., series A;
N1, N2, N3, N4, N5, N6 and N7—Benjamin Cle-ra-tone vibrationless sockets, No. 9040;
O1, O2 and O3—Eby engraved binding posts, marked *Speaker plus*, *Speaker minus* and *Antenna*, respectively;
P1 and P2—Amperite automatic filament adjusters, No. 1-A;
Q—Yaxley cable connector and cable, No. 660;
R—Hi-Q "Six" foundation unit, containing the following instruments and hardware:

R1—Drilled and engraved Micarta bakelite panel, 7 by 21 by 1/8 inch;
R2—Drilled metal chassis;
R3 and R4—Two-stage aluminum box shields;
R5 and R6—Brass extension shafts for variable condensers;
R7 and R8—Cam-operating assemblies;
R9, R10 and R11—Grid-biasing resistors;
R12 and R14—Grid suppressors (black);
R13—Grid suppressor (red);
R15—Bakelite grid-leak mounting block;
R16—Bakelite binding-post strip;
Wires, screws, nuts, washers, spacing collars, etc.

diagram in Figure 2. In this diagram the wiring is shown in heavy red lines; the solid red lines indicate wiring above the chassis, while the dotted red lines indicate the wiring that is done beneath the chassis.

The changes in this push-pull arrangement are so clearly indicated in the illustrations as to need no further explanation. It will be wise to check over all of the revised wiring before the push-pull set is placed in operation, being sure to correct any wires mistakenly connected or to add any connections that have been left out.

When the set has been fully constructed and wired up, as shown in Figures 2 and 3, it is ready to be installed and placed in operation.

Installing the Hi-Q Push-Pull Receiver

First of all, the receiver itself may be placed in its cabinet or console; then the recommended accessory apparatus, shown in the combination diagram in Figure 1, may be connected to it. The Balkite "A" power-pack should be installed in the radio cabinet or in one of the compartments of the console and connected up, as shown in Figure 1.

The official Hi-Q power-pack, for the plate supply, should then be placed in a similar position. As stated before, the

power block, No. 713, in the official Hi-Q power-pack will have to be replaced by a new No. 718 type. The converted Hi-Q power-pack should be connected up to the Yaxley cable as shown in the diagram in Figure 1. Notice that the middle binding post on the left-hand side is not used, nor is the brown wire of the Yaxley cable used. A small "C" battery should be connected between the black and the green cables with the negative end connected to the green wire.

A length of double, twisted lamp-cord is to be connected from the two outside left-hand binding posts on the Hi-Q power-pack to the filaments of the two push-pull valves in the set.

The Ferrand oval-cone reproducer is also shown connected, as well as the connection to the light-socket antenna. Of course, a regular outdoor antenna may be used if desired. It is always desirable to install the reproducer on the other side of the room from the receiver, and for this purpose a Belden extension cord is recommended. The two "input" power connections to the Balkite "A" and the Hi-Q "B" power-packs may be spliced in parallel and connected to a plug that is to be inserted into a socket of the 110-volt AC lighting lines.

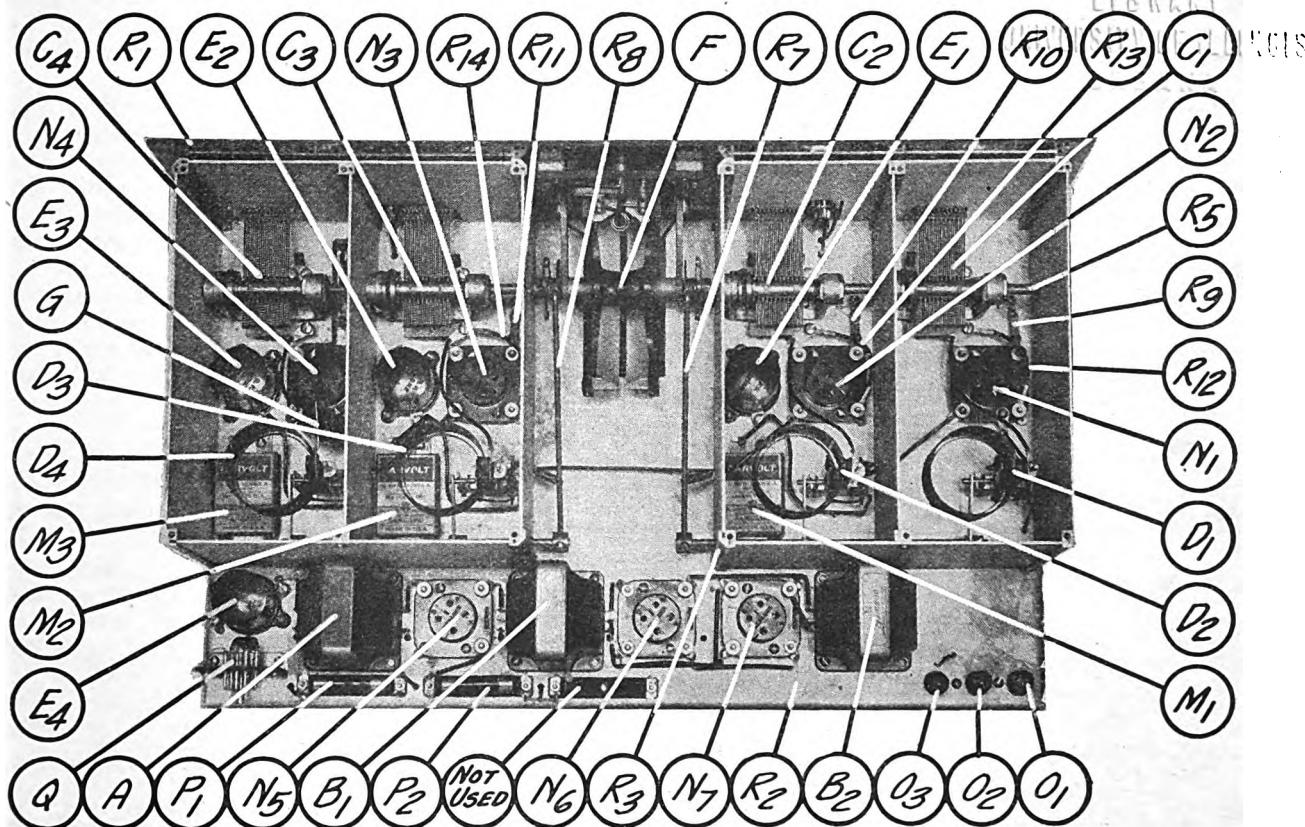
For the adjustment of the official Hi-Q power-pack voltage controls see the article in the January, 1928, issue of POPULAR RADIO.

In operating this receiver, it is also recommended, by reason of the further experimental work done in the POPULAR RADIO Laboratory, to use the new Zetka ZRF type valves in the three high-frequency stages. The new type Zetka ZD detector valve should be used in the detector socket. In the first low-frequency stage a Zetka ZAF valve may be used and the new type Zetka ZO last-stage amplifier valves are strongly recommended for the push-pull arrangement.

These new valves have been found to "pep up" the results obtained from the receiver to such an extent that much greater distance reception and more powerful and better-balanced reproduction will be obtained.

To turn "on" the receiver all that is necessary is to switch "on" the lamp socket that is feeding the "A" and "B" power-packs.

This combination should give the owner of such a set an added pride of ownership, as well as an added appreciation of the many new and excellent program features that are being broadcast from the leading stations.



THE RECEIVER VIEWED FROM ABOVE

FIGURE 3: The new instruments necessary for the addition of push-pull amplification to the Hi-Q "Six" are shown in the picture above on the lower side of the sub-panel. They are B1 and B2, the input and output push-pull transformers, and valve socket, N7. The filament control which is not used in the new circuit is also indicated above.



IN THE PROFESSIONAL SET BUILDER'S SHOP

Practical pointers and kinks to increase the efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, aided by a well-equipped Laboratory, will find it and present the details here to our readers in a practical and concise manner.

Milliamperes, Volts, Ohms and Watts in Fixed Resistors

JUST so long as fixed resistors existed only for the purpose of grid-leaks and coupling resistances in radio applications, the matter of current-handling capacity meant little or nothing to the radio engineer and enthusiast. We were then dealing in minute currents. Today, however, with the present extensive use of radio power-packs in which the energy runs as high as an ampere, particularly in the new "ABC" high-voltage power-packs, the radio experimenter may well begin to think in terms of temperature coefficient, impressed voltage and current-carrying capacity in watts rather than in micro-watts.

In an effort to bring home the relationship between volts, ohms and watts, and between milliamperes, ohms

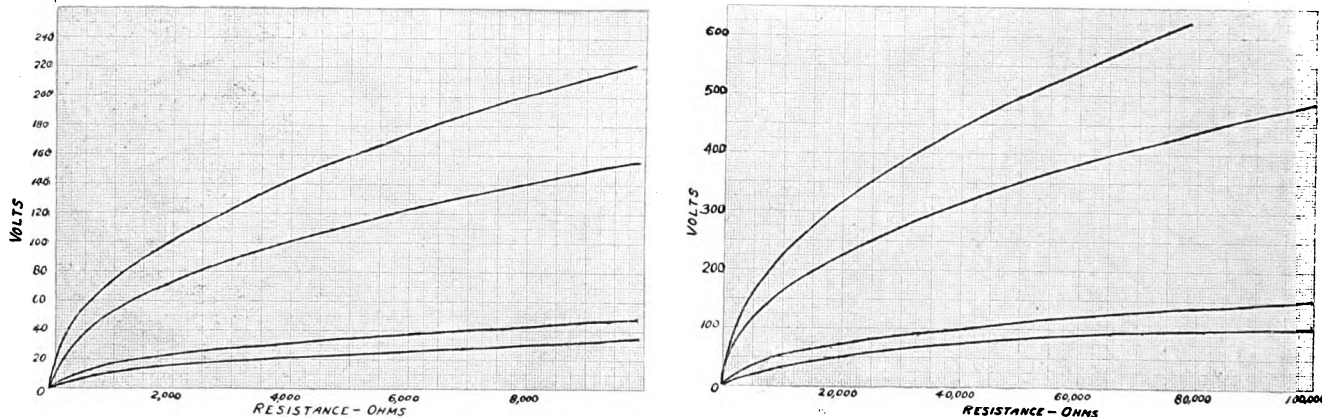
and watts, in the application of fixed resistance values, the Engineering Department of the International Resistance Company has worked out the accompanying graphs, which permit anyone to solve problems in fixed resistors without having to resort to intricate formulas and extensive mathematics. These curves, shown in Figure 1, therefore make it simple and expeditious for the engineer or layman to determine the maximum safe voltage which may be applied directly across a resistor of given resistance and power rating. Similar curves, given in Figure 2, deal with the relationship between milliamperes, ohms and watts.

It will be noted that two graphs for each relationship are included for the purpose of covering a wide range of resistance values with accuracy. The left-hand chart in Figure 1 covers the

range from 0 to 10,000 ohms, while the right-hand chart covers the range from 0 to 100,000 ohms. By dividing the ohm scale by 1,000 and the voltage scale by 100 we may read the relationship in volts, watts and megohms. The graphs in Figure 2 cover similar ranges. Hence the entire range of resistances encountered in ordinary radio work is covered in these graphs.

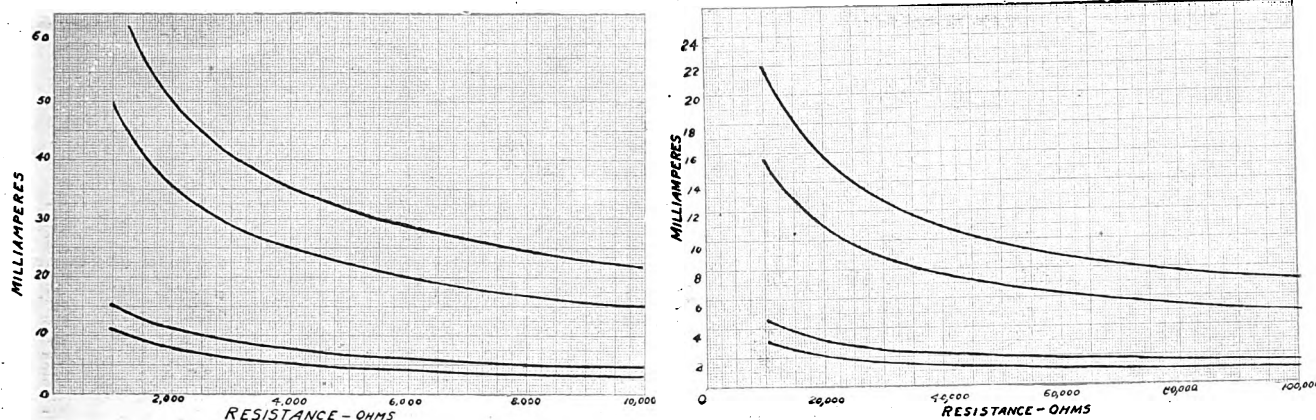
Four curves are given in each graph, namely, that for a 5-watt, a 2.5-watt, a 0.25-watt and a 0.125-watt resistor.

By means of these curves the experimenter can determine just how much energy each class of resistor will handle for a given impressed voltage across its terminals. For example, let us deal with the voltage that might be safely impressed across the terminals of a 10,000-ohm standard 5.0-watt metallized resistor. The answer is



TWO GRAPHS OF VOLTS, OHMS AND WATTS

FIGURE 1: The curves in these two graphs are, from top to bottom, for resistors of 5, 2.5, .25 and .125 watts current-handling capacity, respectively, and indicate the voltage that can be safely handled by resistors of from 0 to 100,000 ohms. By dividing the ohm scale by 1,000 and the voltage scale by 100, we may read the relationship in volts, watts and megohms.



GRAPHS FOR MILLIAMPERES, OHMS AND WATTS

FIGURE 2: The curves in these two graphs are, from top to bottom, for resistors of 5, 2.5, .25 and .125 watts current-handling capacity, respectively, and indicate the current that can be safely handled by resistors of from 0 to 100,000 ohms. By dividing the ohm scale by 1,000 and the milliampere scale by 100, we may read the relationship in milliamperes, watts and megohms. Thus the whole range of resistances may be covered.

found to be 224 volts. In the case of the 2.5-watt resistor, on the other hand, it is 158 volts. With this example, the radio engineer or layman can figure out how high a voltage may be impressed across the terminals of any resistor, if its wattage capacity is known, or, looking at it from the other angle, what capacity resistor, for a given resistance, is required to take care of a given voltage or current.

These curves have been worked out for the Durham resistors and the Durham power-ohms, which are conservatively rated as to their current-carrying capacity.

—F. R. EHLE

Hints on the LC-28

CONTINUED operation of the LC-28 receiver has brought to light some points which will be of interest to the many constructors of this remarkable receiver. Among these are some suggestions which have been passed along to POPULAR RADIO Laboratory by readers who have constructed the receiver, so that this article really serves as a sort of closed forum for LC-28 fans.

During the construction of the receiver it is extremely important to make sure that the terminals of the various parts be kept well clear of the chassis in order to avoid any chance for short-circuits later. Several constructors found difficulty in this source, particularly in connecting the positive filament and the plate terminals of the valve sockets. These connections were left projecting out beyond the soldering lugs on the sockets, and when the sides of the shields were put in place a contact was made between the socket terminals and shields, with the result that the receivers would not operate, and in some cases the volume-control rheostat or the choke coils were damaged,

due to the short-circuiting of the "A" or "B" supply respectively through these instruments.

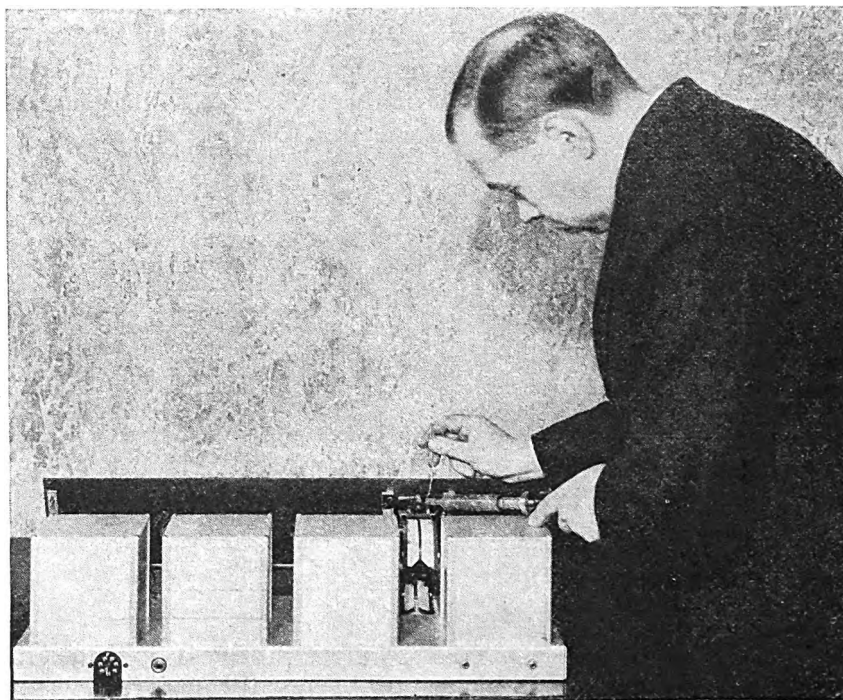
Another cause for short-circuits has been the use of resistor mountings in which the metal contact clips extended down under the base in such a manner that they made contact with the metal chassis when fastened in place. The result of this error is an inoperative receiver or one which operates poorly. No real damage can result from this source, however.

Wiring the Dial Light

The wiring of the dial light was

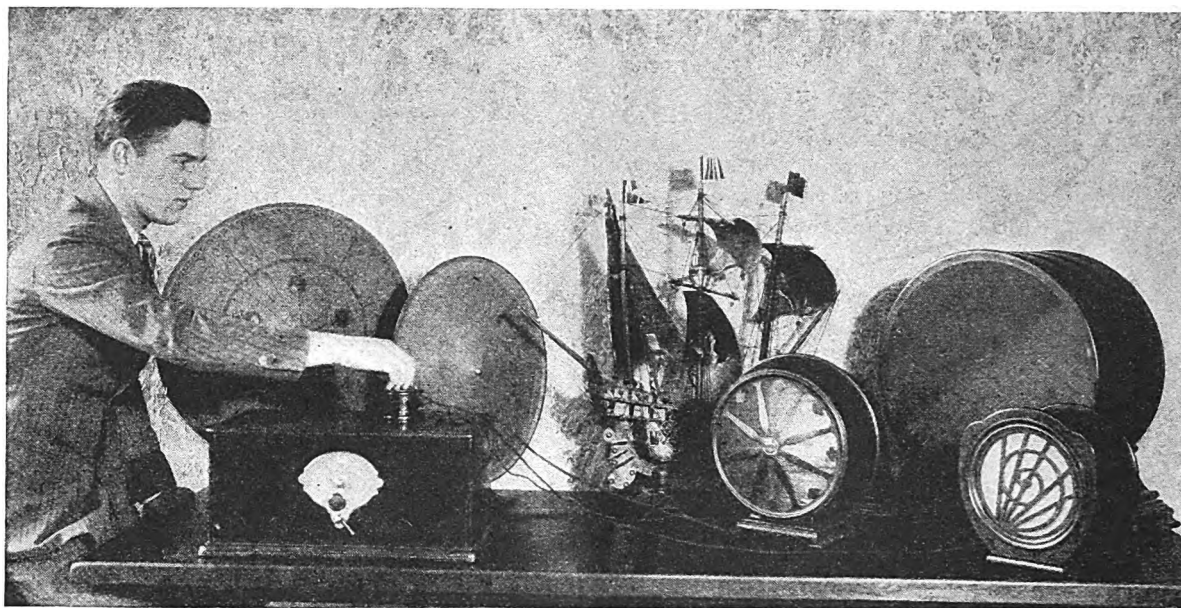
omitted in both the schematic and picture-wiring diagrams in the October issue. The proper connections are easily made by connecting a piece of insulated wire from the lowest of the three terminals on the rheostat to the left-hand terminal of the dial light (left hand when looking over the top of the front panel). The other side of this circuit need not be wired, as it is connected through the metal panel by removing the insulating washer which is under the lock-nut at the top of the bronze plate on the front panel. When connected in this manner, the

(Continued on page 153)



CONNECTING THE PILOT LIGHT

The connections for the pilot light on the LC-28, which were omitted in the constructional article in the October number, are described in the article on this page.



ARISTOCRATS OF THE TONE WORLD

This picture shows a corner of the POPULAR RADIO demonstration room where some of the new reproducers are being given a competitive try-out. Such "actual practice" tests as this supplement the electrical tests and physical examination that these units must submit to in order to be included in these columns.

What's New in Radio

Conducted by

THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.



A Triple-Rate Trickle Charger Unit

Name of instrument: France "dry" trickle charger.

Description: This trickle charger has an advantage over most others in that it will provide any one of three values of charging current. For use with a battery that is under heavy service, as with a receiver that draws 2 amperes per hour or more for a period of 8 hours per day, the high charging rate of this charger will keep the battery fully charged. Where the requirements are less strenuous, one of

the two lower current taps may be used to provide a charging rate of either $\frac{1}{2}$ ampere or $\frac{3}{4}$ ampere per hour. The charger employs a dry type of rectifier which requires no attention. This rectifier, together with the transformer and other parts, is inclosed in a perforated metal case on the front of which are four insulated binding posts. One of these binding posts is for connection to the "A" positive (+) terminal of the "A" battery, while the "A" negative (-) terminal of the battery is connected to any one of the other three binding posts, depending on the amount of charging current desired.

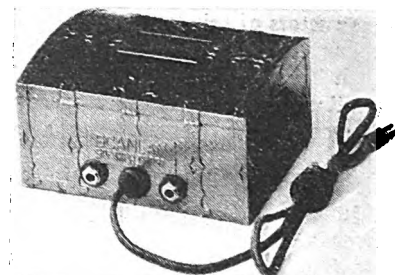
Outstanding features: Requires no upkeep attention. Provides an adjustable charging rate.

Maker: France Mfg. Co.

An Attractive-Looking Output Transformer

Name of instrument: Speaker "Chest" output transformer.

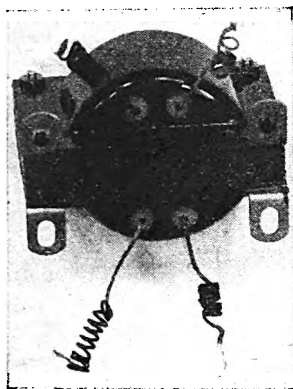
Description: This unit consists of an output transformer which is inclosed in a metal case and has the appearance of a small strong box or chest. It



is intended primarily for use with a receiver which does not contain an output transformer, or filter, and which therefore requires that such a device be located outside of the receiver proper. This explains why such care has been taken in the appearance of this unit. It is equipped with an extension cord for connection to the output terminals of the receiver, and has two tip jacks to accommodate the tips of the reproducer cord.

Outstanding features: Protects the reproducer windings from high DC currents present in the plate circuit of power amplifier valves. Fine appearance. Readily installed without any tools.

Maker: Scanlan Electric Mfg. Co.



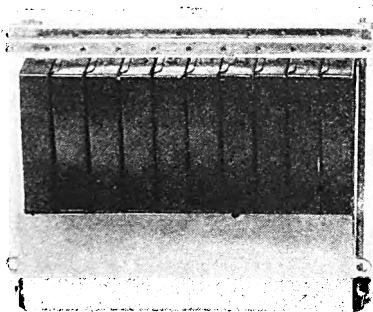
A Transformer for the Home Set Builder

Name of instrument: F M C, type 10693, low-frequency amplifying transformer.

Description: For the first time a low-frequency transformer of the style used in most commercial made receivers is made available to home set constructors and the professional builders of custom made receivers. Outside of it being a transformer of good quality, it is so constructed that it is easy to install and wire. The terminals are in the form of five-inch wire leads which may be cut to the desired length as the transformer is connected into the circuit. It is a plain product in which all of its value is in the transformer itself and not in a fancy covering, etc. It may be mounted either on top or beneath sub-panel.

Outstanding features: Low cost. Easily wired. Small in size. Neat in construction. Completely inclosed in metal case, thus reducing the danger of damage to wiring.

Maker: Ford Radio & Mica Corp.



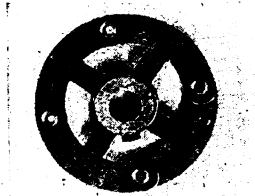
Make Your Own Condenser Assemblies

Name of instrument: "Farapak" condenser assembly rack.

Description: This device permits the experimenter or constructor to build a condenser unit with any combination of capacities required. It consists of metal fittings which form an adjustable rack. In this rack are placed a sufficient number of 1 mfd. condensers to make up the required total capacity. The two thumb nuts are then tightened and the condensers are held tight together in the form of a single block. Spring terminal strips are also provided to eliminate the necessity for soldering connections to the individual condenser terminals.

Outstanding features: For use in "B" power-packs, etc. Any desired combination of capacities can be readily made up in a single unit. When assembled, the condenser block may be easily mounted in any convenient position by means of the mounting holes provided in the base and back of the rack. The assembled unit is quite sturdy and substantial.

Maker: Globe Art Mfg. Co., Inc.



A Coupling for "Ganging" Condensers

Name of instrument: Insulated flexible coupling.

Description: The coupling consists of two "H" shaped pieces of phosphor-bronze which are fastened together in such a manner that they are insulated from one another and have their cross-arms at right angles. On each cross-arm is fastened a brass bushing equipped with two set-screws. If it is desired to couple two tuning condensers together, but still have their shafts insulated from each other, they are lined up with their shafts end to end, but with the coupling between the shaft ends. The bushings on the coupling are slipped over the ends of the two shafts. When the set-screws in the bushings are tightened, the two condensers may be operated together as one. In addition to coupling the two condensers together, the flexible feature of the coupling permits smooth operation, even though the two shafts may not be exactly lined up. These bushings find other uses also, as in attaching drum dials to shafts of condensers, etc.

Outstanding features: Insulation between the halves of the coupling. Flexible. Durable. Positive grip on the shafts of instruments assured by double set-screws.

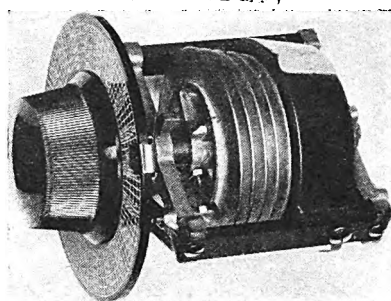
Maker: Hammarlund Mfg. Co.

A Power Amplifier for the Output of the Receiver

Name of instrument: Centralab tone amplifier, model 100 for storage battery operation or model 200 for dry cell operation.

Description: This unit consists of a complete stage of power amplification and an output filter, all inclosed in a neat walnut finished wood cabinet. It is to be connected to the output of any receiver and therefore does not replace the present amplifier. Connections are made without any rewiring and without any tools. The amplifier uses a 171 type power valve and includes a volume control which is operated by the knob on the front of the cabinet.

Outstanding features: Its use adds one stage of power amplification to any receiver. Can be installed in a few minutes. Increases the normal volume of a receiver and tends to im-



A Condenser That Requires No Vernier Control

Name of instrument: Helicon variable condenser with dial.

Description: This condenser is unusual in appearance, operation and control. Instead of consisting of two sets of plates, one set of which moves in an arc to mesh within the other, the rotor of the Helicon condenser is in the form of a large screw with a deeply cut thread. The stator corresponds to the threads inside of a nut. Five complete turns of the shaft, upon which the rotor is mounted, are required to completely mesh the rotor within the stator, as compared with a half turn in the case of the standard type of variable condenser. As the shaft of the Helicon is turned, the rotor screws into the stator, but with sufficient clearance between the two to avoid touching. The dial provided with the condenser is divided into 500 divisions and works in conjunction with a moving pointer. The marking of the dial is laid out in the form of a spiral, with zero at the outer edge and 500 at the inner edge. As the shaft is turned to increase the capacity, the pointer moves in toward the center of the dial. Thus when the condenser is turned to provide half of its capacity the pointer moves into the third row of calibrations on the dial, where the half-way calibration is found. At full capacity the pointer is over the inner side of the dial, where the calibration ends at 500.

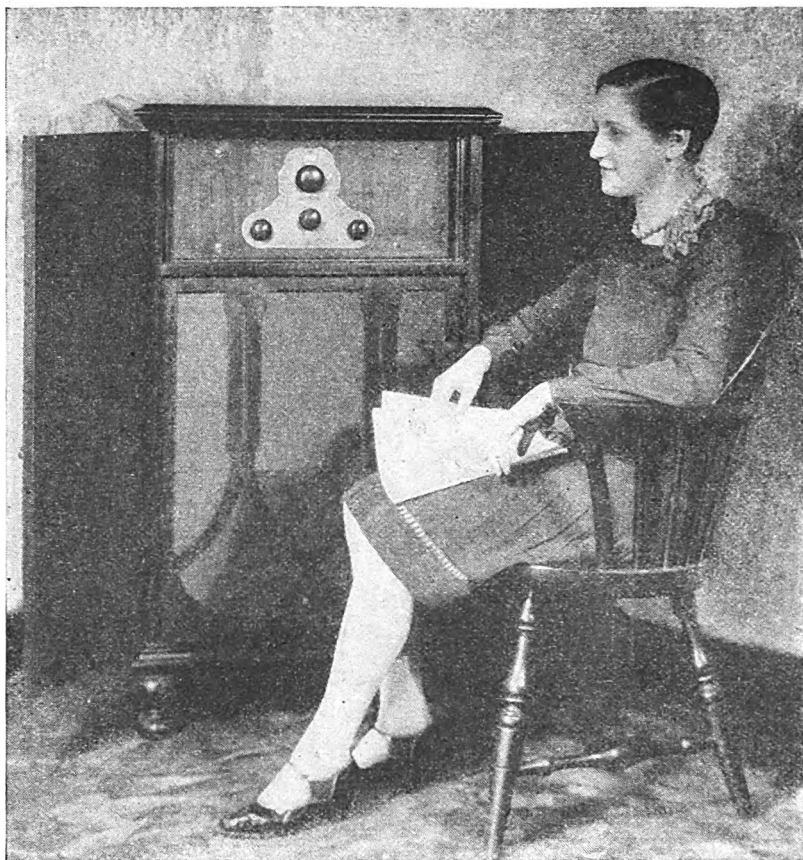
Outstanding features: Smooth and gradual adjustment of capacity requiring five turns of the dial for full variation from minimum to maximum capacity.

Maker: Helicon Radio Condenser Corp.



prove tone quality. Includes output filter. For dry cell receivers the tone amplifier employs a 120 type power valve.

Maker: Central Radio Laboratories.



No Batteries Are Required for This Receiver

Name of instrument: Monarch All Electric radio receiver, console model.

Description: This receiver is, first of all, an absolutely batteryless receiver, with all of its operating current drawn from the house lighting lines. Just turn the switch and off it goes, day in and day out, with absolutely no upkeep attention required.

The receiver is a six-valve unit and includes three stages of high-frequency amplification, a detector stage and two stages of transformer-coupled, low-frequency amplification. There are three tuned circuits so arranged as to be tuned by a single control knob on the front panel. The design of the tuning condensers, by means of which this single control is accomplished, is unique and most simple. The rotors of the condensers are actually a single unit, while the three corresponding groups of stator plates are disposed around the center shaft on which the multi-rotor is mounted. Direct coupling of the tuning condensers, as used in this Monarch receiver, does much to eliminate back-lash, slipping and misalignment.

The circuit employed in the high-frequency amplifier is the well-known Loftin-White balanced circuit. Oscillation is completely eliminated, together with the distortion which so often accompanies near oscillation.

In the low-frequency amplifier two transformers are used and their quality is evident in the deep, rich reproduction of music and speech. Provision is made for the use of a semi-power valve of either the 112 or 371 types in the last stage.

The operating voltages for fila-

ment, plate and grid supplies are obtained from a metal inclosed power-pack which employs a 400-milliamperere rectifier valve of the gaseous type. All the operating voltages are drawn from this valve except the filament supply for the power valve, which employs alternating current from a 5-volt winding on the power transformer within the power-pack. The other five valve filaments are connected in series, thus drawing a

total of 250 milliamperes ($\frac{1}{4}$ ampere), which is readily supplied by this power-pack, with plenty left over for the plate supply.

The power-pack fits into the lower part of the console, with the reproducer. The top of its metal case may be removed when necessary to gain access to the rectifier valve, but is normally left in place, thus preventing any possibility of shock.

Connections between the power-pack and the receiver are simple and fool-proof. The connection cable is permanently attached within the power-pack and the other end terminates in a multi-tip plug which slips into a corresponding socket in the rear of the receiver unit. On one side of the console, where it is out of sight, is a neat toggle power switch, by means of which the power supply is turned "on" and "off."

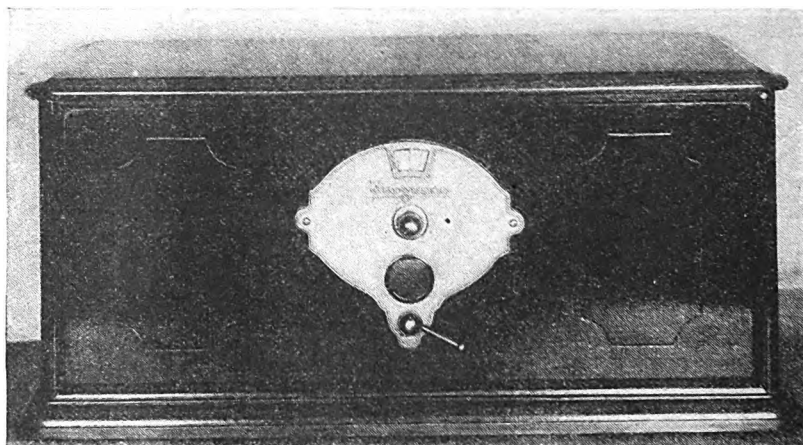
The reproducer has an air column 96 inches in length, which corresponds to a straight horn 8 feet long. But this one is so cleverly designed that it finds plenty of room in the lower part of this console. Acoustically it is excellent.

The antenna and valve requirements are the same as those of any normal 6-valve receiver. Any type of outdoor antenna may be successfully used, although in localities where there is a considerable amount of local interference a short antenna is to be recommended. The valves used are a semi-power valve, as mentioned above, and either five of the 301-a type or four of the 301-a type and a 300-a for the detector socket.

In addition to the console model described, the receiver unit is obtainable in a table mounting cabinet. The power-pack supplied with this table model is the same as that used with the console model, and the receiver itself is also identical.

Outstanding features: Fine appearance. Good tone. Ample volume for home use. Requires no upkeep attention, as it employs no water, acids, batteries or chargers.

Maker: The Monarch Co.



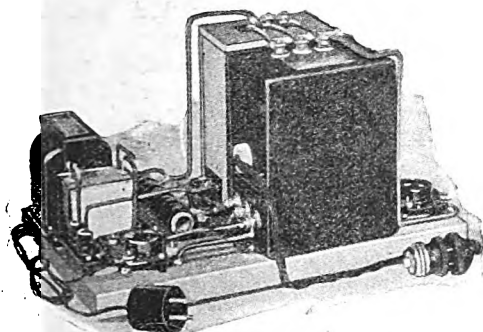
A Highly Selective 7-Valve Receiver

Name of instrument: Ferguson 7-valve receiver.

Description: The Ferguson receiver, so far as its operation and appearance are concerned, is one of the simplest receivers that has been placed on

the market to date. The front-panel carries a single plate on which is mounted a knob and a lever. The knob provides complete wavelength tuning, while the lever is the volume (Continued on page 158)

How's Your Old Audio Amplifier



**THORDARSON 171 TYPE
POWER AMPLIFIER**

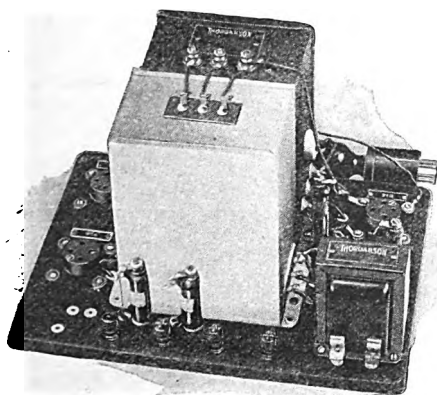
Built around the Thordarson Power Compact R-171, this power amplifier supplies "A," "B," and "C" current for one UX-171 power tube and B-voltage for the receiver. Employs Raytheon B. H. rectifier.

A Home Assembled Thordarson Power Amplifier Will Make Your Receiver

A Real Musical Instrument

IMPROVEMENTS in the newer model receiving sets are all centered around the audio amplifier. There is no reason, however, why you cannot bring your present receiver up to 1928 standards of tone quality by building your own Thordarson Power Amplifier.

With a screw driver, a pair of pliers and a soldering iron you can build any Thordarson Power Amplifier in an evening's time in your own home. Complete, simple pictorial diagrams are furnished with every power transformer.



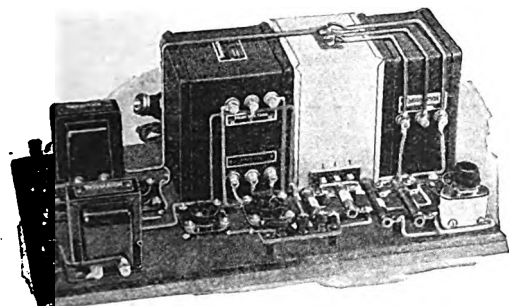
**THORDARSON 210 TYPE
POWER AMPLIFIER**

This amplifier, mounted on a special metal chassis, uses the Thordarson Power Compact R-210. Provides "A," "B," and "C" current for one UX-210 power tube and "B" voltage for the receiver. Employs one 216-B or 281 rectifier.

The fact that Thordarson power transformers are used by such leading manufacturers as Victor, Brunswick, Federal, Philco and Willard insures you of unquestionable quality and performance.

Give your radio set a chance to reproduce real music. Build a Thordarson Power Amplifier.

Write today for complete constructional booklets sent free on request.



**THORDARSON 210 PUSH-PULL
POWER AMPLIFIER**

This heavy duty power amplifier operates two 210 power tubes in push-pull and has an ample reserve of power for "B" supply for the heaviest drain receivers. Built with Thordarson Power Transformer T-2098, and Double Choke Unit T-2099.

THORDARSON

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Wurton and Kingsbury Streets — Chicago, Ill. U.S.A.

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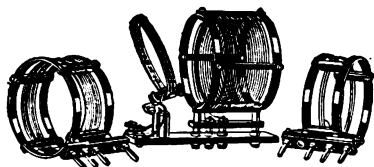
The New TELETROL Uses These AERO Inductances

*You'll want to build it
to enable your present
set to cover short wave
stations*

No single piece of radio apparatus could add more to the value of your present broadcast receiving set than the new Teletrol.

This easily constructed wave lifter enables you to enjoy all the rich amusement offered by 36 different short wave stations—at extremely low cost.

Here are the Aero Inductances used in the Teletrol:



Aero Low Wave Tuner Kit
(Code No. L.W.T. 125) Price \$12.50

Consists of 3 completely interchangeable coils and base mounting. Range 15 to 130 meters. Recognized by amateurs and experts everywhere as the finest short wave kit made. Adopted by U. S. Government and MacMillan and University of Michigan Arctic expeditions.



Aero Oscillator
(Code No. U-100)\$4.00

Also specified for use in the Teletrol. An exceptionally efficient oscillator.

*You should be able to get
these Aero Coils at your
nearest dealer. If not, order
direct from the factory*

Aero Products, Inc.

Dept. 104

1772 Wilson Ave. Chicago, Ill.

Everybody Wants a Push-Pull Amplifier

(Continued from page 133)

ment of it affects the plate voltage; consequently the final adjustment is more or less an arbitrary value for both grid and plate voltages. By making the plate voltage variable over a wide range, the valves may be operated at the maximum efficiency regardless of the load.

The direct current available from the rectifying system is approximately 150 milliamperes. A high current output makes for better voltage regulation and will easily supply sufficient current to operate a multi-valve set with a great reserve of power.

How to Construct the Amplifier

The mounting of the instruments on the wooden baseboard, M, is easily accomplished by reference to Figure 1, so that no further instructions are necessary. The wiring is straightforward and simple, and is shown clearly in the picture wiring diagram in Figure 2. The only precaution necessary is to place some sort of guard over the high-voltage side of the power transformer and to use rubber-covered wire for all connections.

For convenience the 2,000-ohm variable resistor, H, is mounted by means of a metal bracket directly to the "B" negative (—) binding post of the push-pull amplifier, A. When AC current is used to light the filaments of the vacuum valves used in this amplifier, it is a simple matter to utilize part of the plate current to obtain a grid-bias voltage. This is accomplished by connecting the "C" negative (—) binding post directly to the "B" negative (—) post and inserting a resistance, which in this case is the variable 2,000-ohm resistor, H, between the "C" negative (—) and the "B" negative (—) binding posts. By-passing this resistance by a condenser is sometimes helpful in reducing hum.

The filaments of the rectifier valves, together with those of the amplifier valves, are lighted from the low-voltage secondaries of transformers B1, B2 and B3. In the case of the CX-326 type valve, a fixed resistance of 6 ohms,

G, capable of carrying at least 1 ampere, is inserted in one of the filament leads underneath the baseboard. These connections are all shown clearly in the picture wiring diagram in Figure 2.

How to Install the Amplifier

To operate this device, it is simply necessary to connect the primary transformer, D, to the output of the detector valve of a high-frequency pack, such as the LC-28 or the Browning-Drake, or to a phonograph magnetic pick-up. The reproducer is connected to the terminals marked "output" on the push-pull amplifier.

Under normal operating conditions, the vacuum valves, especially the two CX-381 rectifying valves and the two CX-310 type power valves, together with the resistance unit, should get decidedly warm. If the plates of the two CX-310 power valves should get "red" after a period of use, it is an indication that the grid-bias voltage used is improper and the biasing resistance should be adjusted until this condition disappears. It is almost a positive indication that one or more filter condensers are defective if the plate of the rectifier valve suddenly turns "orange" color.

Under operating conditions, with the primary of transformer D open, a hum should be heard in the reproducer. This, however, should almost disappear when the two input terminals are connected to a set or a phonograph pick-up unit.

In an AC-operated device of this sort it is extremely important that the plate and grid voltages of the amplifying valves be adjusted properly, as this helps materially in reducing hum; also the cases of the various parts should be grounded to the "B" negative (—) line. When using a phonograph pick-up with this device, it is sometimes helpful, in removing the sound of the needle scratch, to shunt the input terminals by a small fixed condenser. The proper value can only be determined after experimentation, but will usually be somewhere around .01 mfd.

Why Not Build an AC LC-28?

Why not give the LC-28, the most modern of radio receivers, the final touch of up-to-dateness that comes with efficient light-socket operation? Just a few changes and the job is done; the simplicity of construction that gave the LC-28 its place in the front rank of modern sets has been carried out in the details for the change-over to AC operation. You can't afford to miss this opportunity, and you needn't. Just buy the March issue of POPULAR RADIO, with the complete constructional details.

A Battery-Operated Browning-Drake

(Continued from page 126)

purpose. The "A" supply is obtained, in this combination, from the new Knapp "A" power-pack, that was also fully described in the January, 1928, issue. The new Pacent cone reproducer is recommended for use with this group of radio receiving apparatus.

The combination works excellently from a light socket antenna, although a regular outdoor antenna may be used if so desired.

For the maximum results, in both distance and quality, place a Zetka ZRF type valve in socket N1 and a Zetka ZD type high-sensitivity detector valve in socket N2. These valves, of course, are the ones recommended for the two-valve tuner itself.

In the amplifier the valves recommended are a 240 type Hi-Mu valve for the first socket on the left. (The valves must be inserted with the amplifier turned upside down.) In the second socket from the left place a type AX Ceco valve, and in the third socket place a Ceco type L-10 valve. The Ceco type R-81 rectifier valve is recommended in the last socket on the extreme right.

An ideal way for mounting the various units of this combination receiver is to place the receiver itself in the upper portion of the console cabinet chosen for it with the amplifier and the "A" power-pack in the compartment underneath the receiver. All of the wires running between the units may then be kept neatly inside of the cabinet and no external wiring will be in view when the set is in operation.

The operation of the receiver will be accomplished in exactly the same manner as in the case of the AC model of the receiver.

The primary leads for the "A" power unit and the amplifier should be spliced together and connected to a plug that is to be inserted in a socket of the 110-volt, 60-cycle AC lighting lines. With this combination the switch on the receiver may be left turned "on" at all times and the receiver operated completely from the switch on the lighting socket.

In actual operation it will be found that the results that may be obtained will be considerably in advance over the results obtained with the older styles of Browning-Drake receivers. The set will be more selective and have a greater sensitivity and at the same time be much more stable in operation.

The high-quality resistance-coupled amplifier in the National amplifier insures a tone quality and volume that will please any listener. In fact, the total result will be of an order never obtained before with any of the models of this popular receiver.



Durham Leadership

The Original Metallized Resistor — Adopted by Finest Set Manufacturers — Endorsed by Foremost Radio Engineers — Sold by Leading Dealers!

DURHAM Resistors and Powerohms have won their position of leadership because they have never failed to deserve the recognition of radio leaders who appreciate flawless accuracy and utmost dependability.

Ever since their first appearance, years ago, manufacturers, engineers, professional builders and radio fans have adopted Durhams in steady progression. Today Durhams are in use wherever fine results are a foremost consideration.

If you are not using Durhams now, an experiment with replacements may prove why they are the accepted leaders in their field.



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For "B" Eliminators and Amplifier Circuits. Made in 2.5 and 5 watt sizes in ranges from 500 to 100,000 ohms.



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Made in ranges from 500 ohms to 10 megohms. Standard or Special tips.

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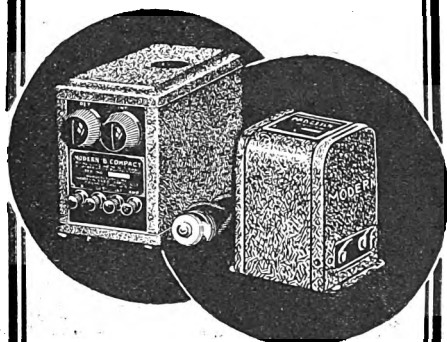
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INTERNATIONAL RESISTANCE CO., 2½ S. 20th St., Dept. A, Phila., Pa.

For Rebuilding Sets for AC Operation



MODERN AC Power Units

The rebuilding of DC sets for light socket operation is simplified by the use of the new Modern AC Power Units. These units consist of the tried and proven Modern "B" Compact, combined with filament lighting transformers and "C" voltage supply—all in one case.

The use of this fine new combination makes the ideal light socket set, but for those having a satisfactory B power supply we are providing a full line of separate filament lighting transformers.

Get acquainted with these new products now.

MODERN Type M TRANSFORMERS

When rebuilding any set be sure to take advantage of the opportunity to improve reception by installing MODERN Type M Audio Amplification.

These splendid large size transformers produce results that are superior to any yet obtained. Faithful reproduction of the full range of audible tones, wonderful volume and ability to stand high voltages without danger of burning out—all this and more in the Modern Type M. Made for either push-pull or straight amplification. Write for circuits and details. Address Dept. P 2

The Modern Electric Mfg. Co.
Toledo, Ohio

MODERN

The Teletrol Wave Lifter

(Continued from page 116)

characteristics that may be operated from the same power source as the receiver to which the unit is used.

How to Construct the Teletrol Wave Lifter

In constructing the unit the first job will be to prepare the wooden baseboard, U, which should be made out of $\frac{1}{2}$ -inch hardwood, cut to a size of 9 by 16 inches. The next work is to mount on the baseboard all of the parts that go to make up the receiver. The relative positions for the various instruments are shown in Figure 1, which shows the top view of the set, and also in the picture wiring diagram in Figure 2.

As all of the parts simply need to be screwed down to the wooden baseboard, the mounting of the instruments is easy. It is probably best to set out the parts in about their correct positions before fastening them down, so that no mistakes will be made. A careful study of the wiring diagram will show the approximate spacing necessary for running the wires between the instruments.

The next job is to drill the holes for the instruments that are to be fastened onto the front panel, T. This had best be done by standing the sub-panel and the baseboard in their correct relative positions and "spotting" the holes necessary for the shafts of the three condensers with a punch-prick. When these are drilled, the spacing for the tuning dial, V, can be laid out with the template that comes packed with the dial. The panel, T, may then be fastened to the baseboard, U, by means of three screws fastened to the panel and into the edge of the baseboard.

How to Wire the Teletrol Wave Lifter

The wiring of the unit should be done with flexible Braidite, and each wire should be run as shown in the picture wiring diagram in Figure 2. If the exact information is carried out, the theoretical circuit shown in the schematic wiring diagram will be fulfilled. A careful check should be made, once this work has been completed, and it would be well to do this checking from both the schematic and the picture wiring diagrams. Notice that some of the leads should be twisted together.

How to Install and Operate the Teletrol

The installation of this unit may be simply made to any radio receiver employing tuned-high-frequency amplification. The unit may be placed in a standard Corbett cabinet, 7 by 13 inches. The antenna wire is taken off the receiver and applied to the antenna post of the Teletrol. This is shown clearly in the combination diagram in Figure 3. Also notice that the antenna terminal of the receiver is to be con-

nected to the output terminal of the Teletrol. The regular ground connection on the receiver is left as before. The Yaxley plug and cable on the Teletrol should be connected up to the "A" power-pack and to the "B" and "C" batteries, as indicated by the dotted wiring in this diagram. The black wiring, of course, refers to the connections for the receiver with which it is to be used.

The vacuum valves recommended for the Teletrol are a radically new type that have a lower internal capacity and also a much lower plate impedance, giving added results in pick-up and amplification. These valves are known as type DA-2 Donle valves and are manufactured by the Donle-Bristol Company.

In using the receiver for short-wave reception, the particular short-wave Aero coil needed for the wavelength desired to be received should be inserted in the socket at "A," shown in the picture wiring diagram. Then the switch on the receiver itself should be turned "on," as well as the filament switch on the Teletrol. All the valves in both sets should then light up. The oscillator of the Teletrol is controlled with the right-hand dial; and this should be revolved until the oscillator frequency lies within the wavelength range of the receiver. It is best to set the receiver somewhere towards the top end of the tuning scale, round a dial set of 90, and then to tune the oscillator dial in the Teletrol until it falls on the same wavelength. This is indicated by a sort of rushing sound or clicking sound when it is set correctly. The small variable output coil of the coil, B, in the Teletrol should then be adjusted so that this effect is most strongly marked. Then the tuning control of the Teletrol should be revolved with the left-hand control turned all the way "in." As the tuning dial, V, is rotated a series of whistles should be heard in the reproducer. The left-hand dial on the Teletrol should then be rotated to a lower setting until the whistling sounds stop and voice signals are heard. This adjustment is rather critical, but can be stabilized by the proper adjustment of the primary coil shown at "A" in the Teletrol.

Of course, all of the short-wave signals that are picked up will not be broadcasting. A great many will be amateur code transmissions that utilize the whistling sounds caused by continuous waves for sending Morse signals, but on going "up" and "down" the range the broadcasting signals can be picked out and dial settings jotted down for each one, also noting which size of antenna coil is used for each particular station, as well as the settings of each of the Teletrol's dials.

The AC Equamatic

(Continued from page 120)

switch. This allows the receiver to be turned "on" and "off" directly from the main panel.

When the wiring is finally completed and rechecked, the set is ready to be installed and placed in operation.

How to Install the AC Equamatic

The receiver itself is first to be placed in the cabinet or console chosen for it and set up in the place where it is to be used.

The installation is such a simple matter that it can be done inside of a quarter of an hour's time. Simply attach the reproducer to the two tip-jacks, as shown in the combination diagram in Figure 1. A light socket antenna may be used with this receiver and it should be connected to the antenna post, as illustrated in the same diagram. The connections from the Yaxley cable to the Majestic "B" power-pack are clearly shown, as well as the connection to the ground, which may be made on any nearby water-pipe or radiator, or other well-grounded connection.

The 110-volt plug and extension cord of the "B" power-pack should be inserted in the socket on top of the power transformer in the receiver, and the input plug and extension cable of the power transformer should be connected direct to the 110-volt, 60-cycle AC lighting line.

The vacuum valves should be set in the sockets, as explained at the beginning of this article.

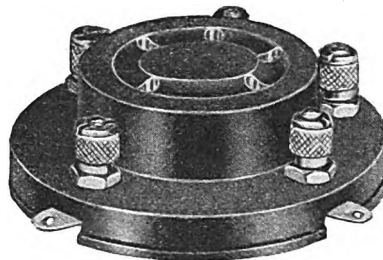
The apparatus recommended in the combination diagram in Figure 1 has been used successfully in the POPULAR RADIO Laboratory and produces excellent all-around results. Of course, a regular outdoor antenna may be used if extreme distance reception is required.

To turn the set "on," all that is necessary is to flip the switch on the panel, and after a period of about 40 seconds the receiver will be ready to operate. The two main dials, U1 and U2, should be rotated until the station is tuned in; then the dials and rheostats may be adjusted for the best results. The two balancing condensers should be adjusted so that the circuits are stabilized and oscillation is eliminated. To do this, rotate the knob on the top of each balancing condenser, one at a time, with a signal fully tuned in, while rotating the first tuning condenser, U1, past the wavelength of the station being received, until the point is found in the setting of the balancing condenser where the set no longer squeals. No further adjustment will be necessary, and from then on the set may be tuned with the two dials and the volume controlled by the small volume control knob on the front of the panel of the receiver.

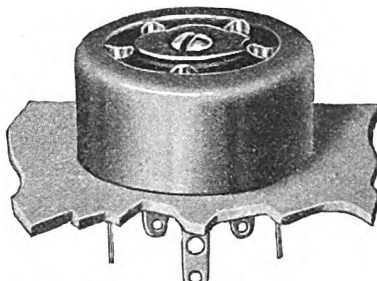
NEW!

NA-ALD A.C. SOCKETS

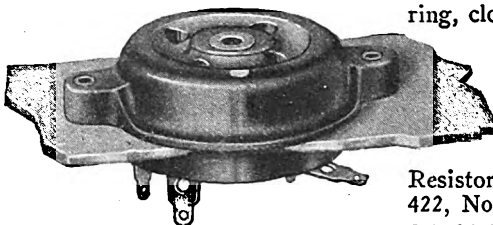
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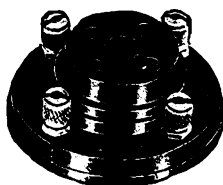
No. 427
For 5 Prong UY 227 Tubes
Price, 50c



No. 423
For 5 Prong UY 227 Tubes
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No. 424
For UX 226 and all UX Brass Tubes
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Price, 65c

Note automatic oscillation controls, automatic locator rings and special contacts.

A socket is not just a socket—not for A. C. tubes. The new A. C. tubes draw up to $1\frac{3}{4}$ amperes. They therefore need the firm, full length contact of Na-ald parallel constant - pressure contacts. The A. C. contacts must also be on the outside of the tube prongs. They need to be sturdy, firm and of sufficient cross section to carry the current. "It's the contact that counts."

IMPORTANT—Na-ald sockets and the new locator rings are covered by patents and patents pending.

Na-ald A. C. sockets are not an adaptation of a battery socket, but are designed particularly to meet A. C. requirements. Note the automatic locator ring; colored for easy visibility and to indicate the type of tube to put in each socket. Green for No. 227 or detector tube, red for No. 226 or all purpose tubes and orange for the power tube. The locator ring makes it possible to aim the tube at the locator ring, close your eyes, turn the tube and it slips smoothly and easily into place. It removes as easily with no clinging springs to jar the heater and shorten its life.

Resistor jacks are incorporated in No. 422, No. 424 and No. 426. Grid resistors or suppressors slip into these jacks or slots and connect in series with the grid prong and the rest of the circuit. When resistor is removed the circuit is automatically closed. See page 3 in the Na-ald A. C. Booklet for list of values of resistances.

Na-ald contacts are nicked phosphor bronze alloy rolled to our specifications. These specifications are the results of the experience and study in the making of millions of socket contacts. Na-ald sockets are made for the set-constructor laboratory, engineers as well as for the largest commercial set manufacturer.

Write today for the story on Na-ald A. C. sockets and booklet
"What to Build."

NA-ALD Sockets are protected by the following patents:
1505329, 1546161, 1580942, 1651660, Re16466, Re16467, Re16469 and many others pending.

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Why Experiment?

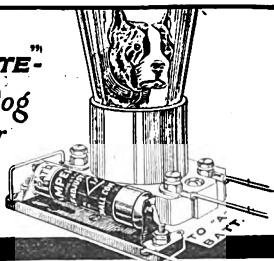
The widespread use of AEROVOX condensers by more than 200 set manufacturers—and the use of AEROVOX PYROHM power resistances by more than 20 eliminator manufacturers—is conclusive evidence of their

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YOU cannot overlook these facts. ... The selection of AEROVOX products by so many of the foremost radio engineers of this country is PROOF that these products will serve you faithfully and efficiently.

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"AMPERITE"
Watch Dog
of Your
Tubes



Simplifies-

1. Tube control—No knobs
2. Wiring—Short leads
3. Panel design—No drilling
4. Tuning—No hand rheostats

Only AMPERITE can automatically keep the temperature or voltage of the filament constant despite variations in "A" battery voltage. Particularly essential with eliminators. Proved for 6 years to be indispensable in every radio circuit. Do not confuse with fixed filament resistors. Accept only AMPERITE. Price \$1.10 with mounting (in U.S.A.). At all dealers.

Write for Free "Amperite Book" of season's best circuits and latest construction data. Address Dept. P. R. 2

Radiall Company
50 FRANKLIN ST., NEW YORK

AMPERITE
The "SELF-ADJUSTING" Rheostat



HARRY NOLTE AT WORK

The dark basement where he builds his radio sets has hardly any light—because he needs none. With nimble fingers he mounts and wires the parts of the receiver in their proper places; only his keen hearing helps him to gauge how well he has built.

A Blind Builder of Sets

By HAL HAZELRIGG

FOUR years ago, Harry Nolte of Evansville, Indiana, went blind. Blindness came to him with the suddenness of a scourge. There was a strange weakening of the sight, whispered side-long conversations by physicians—the dread word "glaucoma"—then darkness, black and impenetrable.

Nolte had been a traveling salesman, happy and popular and a good mixer. He had two hobbies, photography and radio.

Of course, this swift tragedy struck the camera from him but it left him radio.

His nimble fingers soon learned every inch of the complicated construction of his radio set. He began to make his own repairs and improvements upon it. Then came the thought which brought hope into his life; why not make a set of his own?

Amazed at his own facility, Nolte fashioned a complete set, better than the first. Then he made another; then a fourth. He fitted up a workshop in the basement of his home in Evansville, Indiana, a shop which had scarcely any light, because Nolte needed no light.

That workshop became a marvel of precision. With the assistance of his wife, Nolte arranged a place for every bit of wire and every vestige of material. The blind man now reaches out with his hands and in the course of a few days a jumble of wires, metal, wood and screws becomes a radio set.

Nolte knows the joys of the inventor.

He has designed a radio set for the blind. Its dial numbers are on tin, raised in the Braille fashion, and he has originated a card index of stations, also done in the Braille lettering, at which he is an adept.

In Evansville, Nolte's sets have gained a reputation; he has sold nearly two score sets, and now he has on hand more orders than he can fill. He also works on other sets, making improvements and repairs.

Nolte's many friends keep him posted on all new developments printed in POPULAR RADIO and other publications. As soon as one hears or reads of an innovation in the radio industry, he hurries to the blind man and tells him the news.

On the ground floor of the little house above Nolte's workshop, is his "finishing room." Here, Mrs. Nolte helps, staining and painting the sets after her husband has completed the mechanical parts.

"It takes me a week to make a set," Nolte will tell you apologetically; "if I had eyes it could be done in two days. But I get a perfect set, because my more acute hearing detects fallacies in sets, and I can locate the trouble which the sense of touch rectifies."

Nolte enjoys life. His chuckles and smiles prove that. Life in the dark must not be so bad after all. But he is happy because he can twist a few dials and listen to the music of the band and the cheers of the crowds.

In the Professional Set Builder's Shop

(Continued from page 143)

dial light will operate automatically as the receiver is turned "on" and "off."

Special Purpose Valves

There have been some inquiries as to whether the special Zetka valves specified in the descriptive article offer sufficient advantage to warrant their use. This question can best be answered by the statement that the use of the type ZRF high-frequency amplifier valves and the Zetka ZD (the new type number for the Zetka 200-a valves) detector valve provide an increase of 30 per cent in the overall high-frequency amplification over that obtained with valves of the 201-a type when used in this receiver.

Valves of the 112-a type may be used in the three high-frequency stages if desired, but their use is not recommended because of their high plate-current consumption when used without a higher "C" bias.

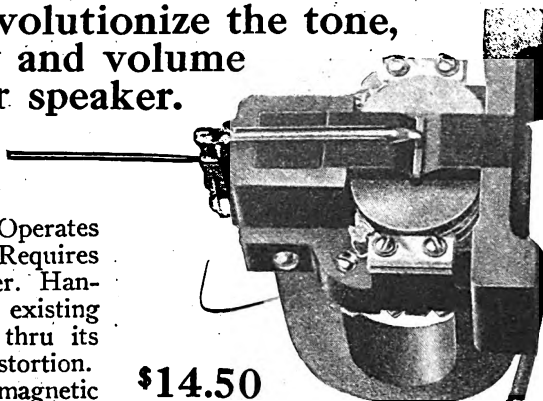
To Operate Without an Antenna

Under most conditions it is possible to operate the LC-28 receiver without an antenna of any sort. This is accomplished by disconnecting the ground from the "ground" tip jack at the rear of the chassis and connecting it to the "antenna" tip jack. When this is done the electric light lines which supply the alternating current to the power-pack and the water pipe or whatever medium is used for the ground form what practically amounts to a large loop circuit, because of the fact that both are grounded at their far ends. This plan will work only when a power-pack is employed; otherwise there will be no connection to the light lines. In battery-operated receivers approximately the same results may be obtained by connecting the ground as usual and employing a light-socket antenna for the antenna.

Naturally the effectiveness of these types of antennas varies according to several factors over which the receiver owner has no control, such as the length of the lighting lines from the receiver to the point where they are grounded and the length of the water pipe above ground. There seems to be little way of determining in advance how this system will work in any particular location. In private houses where there is a long stretch of line outside this antenna system seems to be very effective and also on the upper floors of apartment houses. In some cases reception is better than with a good outdoor antenna, while in others it is comparable with only a short outdoor antenna. If the "pick-up" with this system is great, it may be well to experiment with different sizes of series fixed condensers in the ground lead. A capacity of .00025 mfd. may be

New - Different - Better!

The new BRIELLE MOTOR will revolutionize the tone, quality and volume of your speaker.



\$14.50

will bring you a Brielle B. A. Motor if your dealer cannot supply you. This unit is all ready to be installed in your own cone speaker. Mail check or money order. We will pay the postage.

For \$5.25 additional, you can build your own Brielle Cone Speaker—with special Vibrotex Cone. Send for the Brielle Kit containing all the materials and complete directions for assembly. The Brielle Kit is specially designed for the new Brielle B. A. Motor. Cone may be obtained in 3 sizes, 24"—30"—36".

Look at this unit. Operates on 45 to 800 volts. Requires no out-put transformer. Handles the output of existing Power Tubes direct thru its own coils, without distortion. Notice the direct magnetic path—producing great sensitivity. Note the broad laminated pole face and large armature surface.

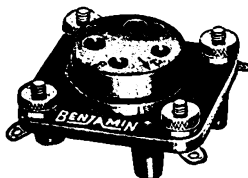
Experts say the New Brielle B. A. Motor is way in advance of ordinary design—sturdy, simple, yet unusually efficient.

G. R. PENN MANUFACTURING COMPANY
34 West 3rd Street New York, N. Y.

BENJAMIN Cle-Ra-Tone Sockets

Red Top
For Standard UX Type Tubes. For quick and easy finding of the correct position of the tube and the prongs.

Green Top
A new Five Prong Socket for A. C. Detector Tubes. Especially designed for heavy current-carrying capacity for these new tubes.



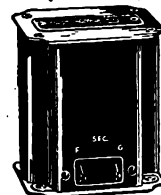
You can tell immediately into what socket each tube should go. No more mistakes, hesitation or confusion. Improves the appearance of the set.

Cle-Ra-Tone Sockets are spring supported to absorb the shocks that distort tonal qualities. The tube "floats" on four finely tempered springs, which absorb shocks and jars from slamming doors, passing traffic and other disturbances caused by outside vibrations. One-piece terminal to tube connection. Positive contacts. Knurled nuts for binding post connections or handy lugs for soldering.

Cle-Ra-Tone Sockets have been chosen for practically every prominent circuit for several years.

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Completely shielded. Tested at equivalent of 1,000 volts d. c. between windings and between each winding and case.

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are accurate and stay accurate.

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Get this book chock full of wiring diagrams, charts, specifications, and ideas on how to improve the tone quality and distance-getting ability of any radio receiver.

This ready reference guide on resistance coupled amplification shows you how to remodel your own set for better radio reception.

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Gentlemen:

I want to improve my radio. Send me a copy of "Resistance the Control Valve of Radio," for which I enclose 25c.

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P. R. 2

suitable, while in other cases the required capacity may run as low as .0001 mfd.

Adjusting Condensers for Maximum Sensitivity and Selectivity

In order to make sure that the three grouped tuning condensers are exactly in step, it is advisable to loosen their set screws and then adjust each one separately to a given station, after which they may again be tightened on the shaft and will require no further attention.

The best method for doing this is to first adjust the three condensers so that their plates are entirely meshed at a dial setting of 100. Then tighten them on the shaft and tune in some high wavelength station. The rotors of condenser J3 and J4 should then be loosened by turning the two set screws which make each fast to the long shaft.

Starting with condenser J1, which is the first one to the right of the drum dial, grasp the tips of its rotor plates with the fingers and thus tune it to the point of maximum signal strength.

Now adjust the drum dials for maximum signal volume from the station. The right-hand dial will tune only the condenser J2, inasmuch as the other two condenser rotors are no longer attached to the shaft. Now, leaving the drum dials strictly alone, tune each of the remaining condensers individually by grasping the tips of their rotor plates with the fingers and moving them slowly until the best setting of each is found, as judged by the strength of the signal from the station. Finally tighten the set screws again and the job is completed.

With this done, the adjustment will hold good for other wavelengths and the result of the three circuits being in exact resonance will provide a surprising degree of sharpness in tuning and added sensitivity. It is a good plan at this point to firmly tighten the screws which attach the condensers to the chassis.

Synchronizing the Dial Settings

The reason for not controlling all four tuned circuits with a single dial is that the value of the antenna has some effect on the settings of the tuning condenser of the first circuit. It naturally follows that when the first circuit is tuned by a separate condenser the dial settings will in some cases not agree exactly with the setting of the dial which controls the grouped condensers. The difference between the dial settings will remain practically the same throughout almost the entire range of the dials, however.

In view of these facts, it will be found convenient to loosen the set screws of the antenna tuning condenser, J1, and with a station tuned in set its control dial to agree with the set-



ADJUSTING THE CONDENSERS

By a proper adjustment of the variable condenser of the LC-28, the tuning may be sharpened to a great degree, and the two dials may be made to read the same for any station tuned in.

ting of the other dial. Then tighten the set screws again and thereafter the two dials will tune alike as long as the same antenna is used.

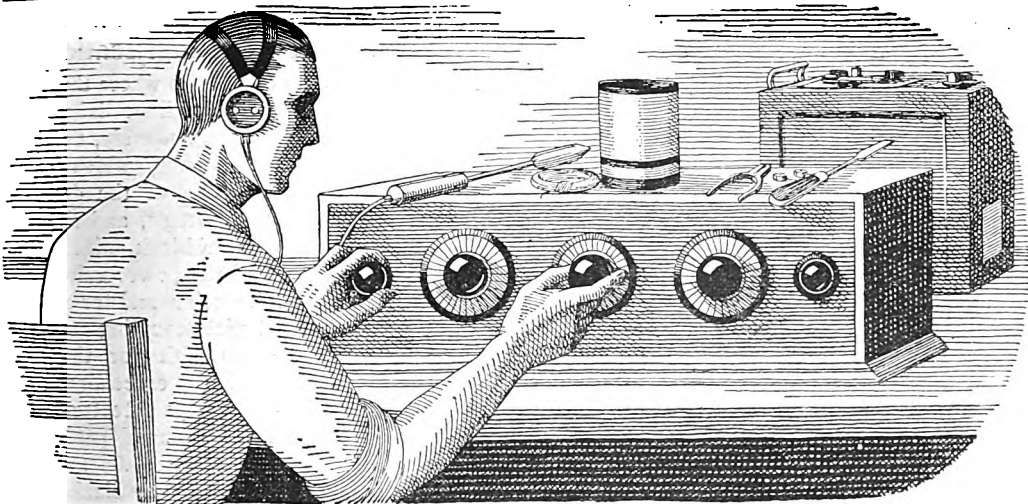
Tighten All Mounting Screws

Before putting the receiver into permanent use, all of the mounting screws should be gone over with a screw driver. This applies particularly to the screws at the top and bottom of the shield corner posts. This will insure against the screws working loose at some later date and also will provide the maximum effectiveness of the shielding.

High-Frequency Plate Voltage Not Critical

The voltage for the "B" supply for the three high-frequency valves was specified in the descriptive article as 90 volts. The use of 67½ volts or thereabouts will provide practically the same results. It is worth while to experiment a little with this, as there is nothing gained by using higher voltages here than the lowest that will provide maximum results. The current drain for the high-frequency valves is reduced 50 per cent when the plate voltage is reduced from 90 to 67½ volts. Where batteries are used for the "B" voltages, and even with some power-packs, this saving of current is worth while, particularly as it means that in the case of most power-packs the saving of current at the 90-volt tap results in somewhat higher voltage being available for the operation of the power valve.

POPULAR RADIO will welcome pointers from other builders of the LC-28.



If all the Radio sets I've "fooled" with in my time were piled on top of each other, they'd reach about halfway to Mars. The trouble with me was that I thought I knew so much about Radio that I really didn't know the first thing. I thought Radio was a plaything—that was all I could see in it for me.

I Thought Radio Was a Plaything

*But Now My Eyes Are Opened, And
I'm Making Over \$100 a Week!*

\$50 a week! Man alive, just one year ago a salary that big would have been the height of my ambition.

Twelve months ago I was scrimping along on starvation wages, just barely making both ends meet. It was the same old story—a little job, a salary just as small as the job—while I myself had been dragging along in the rut so long I couldn't see over the sides.

If you'd told me a year ago that in twelve months' time I would be making \$100 and more every week in the Radio business—whew! I know I'd have thought you were crazy. But that's the sort of money I'm pulling down right now—and in the future I expect even more. Why only today—

But I'm getting ahead of my story. I was hard up a year ago because I was kidding myself, that's all—not because I had to be. I could have been holding then the same sort of job I'm holding now, if I'd only been wise to myself. If you've fooled around with Radio, but never thought of it as a serious business, maybe you're in just the same boat I was. If so, you'll want to read how my eyes were opened for me.

When broadcasting first became the rage, several years ago, I first began my dabbling with the new art of Radio. I was "nuts" about the subject, like many thousands of other fellows all over the country. And no wonder! There's a fascination—something that grabs hold of a fellow—about twirling a little knob and suddenly listening to a voice speaking a thousand miles away! Twirling it a little more and listening to the mysterious dots and dashes of steamers far at sea. Even today I get a thrill from this strange force. In those days, many times I stayed up almost the whole night trying for DX. Many times I missed supper because I couldn't be dragged away from the latest circuit I was trying out.

I never seemed to get very far with it, though. I used to read the Radio magazines and occasionally a Radio book, but I never understood the subject very clearly, and lots of things I didn't see through at all.

So, up to a year ago, I was just a dabbler—I thought Radio was a plaything. I never realized what an enormous, fast-growing industry Radio had come to be—employing thousands and thousands of trained men. I

usually stayed home in the evenings after work, because I didn't make enough money to go out very much. And generally during the evening I'd tinker a little with Radio—a set of my own or some friend's. I even made a little spare change this way, which helped a lot, but I didn't know enough to go very far with such work.

And as for the idea that a splendid Radio job might be mine, if I made a little effort to prepare for it—such an idea never entered my mind. When a friend suggested it to me one year ago, I laughed at him.

"You're kidding me," I said.

"I'm not," he replied. "Take a look at this ad."

He pointed to a page ad in a magazine, an advertisement I'd seen many times but just passed up without thinking, never dreaming it applied to me. This time I read the ad carefully. It told of many big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. Well, it was a revelation to me. I read the book carefully, and when I finished it I made my decision.

What's happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months I've had a Radio business of my own. At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that

day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

Now I'm making, as I told you before, over \$100 a week. And I know the future holds even more, for Radio is one of the most progressive, fastest-growing businesses in the world today. And it's work that I like—work a man can get interested in.

Here's a real tip. You may not be as bad off as I was. But think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years—making the same money? If not, you'd better be doing something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you inexpensively in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

Take another tip—No matter what your plans are, no matter how much or how little you know about Radio—clip the coupon below and look their free book over. It is filled with interesting facts, figures, and photos, and the information it will give you is worth a few minutes of anybody's time. You will place yourself under no obligation—the book is free, and is gladly sent to anyone who wants to know about Radio. Just address J. E. Smith, President National Radio Institute, Dept. 2K, Washington, D. C.

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Dept. 2K, Washington, D. C.**

Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving all information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesman will call on me.

Name

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PRICE

\$12.50For either A. C. or battery model—
complete ready for use.**The NEW A. C.
model Pacent
PHONOVOX**

(THE Electric Pickup)

**enables owners of A. C. tube sets to
electrify their phonographs**

No longer is it necessary, because you own an A. C. Tube set, using the U. Y. 227 or C. Y. 327 tubes, to be denied the pleasure and enjoyment of listening to your favorite records played electrically.

By simply attaching the New A. C. Model Pacent Phonovox to your radio and phonograph, you obtain the same superb tone quality—the greatly widened range of reproduction as that of the costly electric phonograph—at a fraction of its cost—only \$12.50.

Only two minutes are required to at-

tach or detach the Pacent Phonovox, without tools or making any changes in the wiring.

If your set is storage battery operated, the Battery Model Phonovox will give you the same superlative results. With either model, there is nothing to wear out; no adjustments ever needed, and will give you years of perfect service.

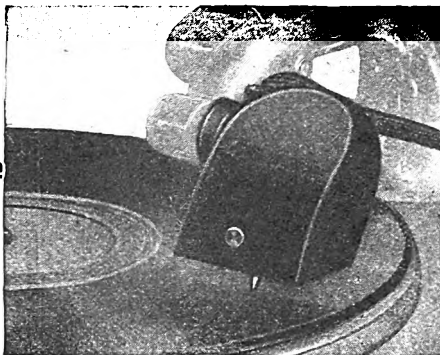
To avoid the possibility of disappointment, ask for it at your radio or phonograph dealers, by name—Pacent PHONOVOX, and accept no substitute.

Sold and demonstrated by dealers everywhere

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91-7th Avenue New York City

Makers of the famous Pacent Balanced Cone

Manufacturing Licensee for Great Britain and Ireland, Igranic Electric Co., Ltd., Bedford, England

**Improving Resistance-
Coupled Amplification**

THERE are two places where the usual resistance-coupled amplifier is susceptible of improvement, namely, the first plate-coupling resistance, which is in circuit with the plate of the detector valve in the usual circuit, and the last grid resistance or grid-leak, which is in the grid circuit of the power valve.

The usual .1 megohm resistor recommended for all plate-coupling resistors will often be too high for the first plate-coupling resistor, especially when using the UX-200-a type detector valve. The resistance valve should preferably be much lower, say about .02 megohm if less than 180 volts is available. Or, in order to adjust this value for maximum efficiency, a variable high resistance may be used in place of the fixed resistor.

In the grid circuit of the power valve the usual ¼-megohm value recommended is also much too high, except in the case of the lower rating power valves, or those of the UX-112 or smaller types. For the UX-112 and especially for the UX-171 and UX-210 types, the value should be from 25,000 to 100,000 ohms, and this value is best determined by using a reliable variable high-resistance unit, which is capable of handling the heavy current without resistance change or noise. Otherwise, in the balance of the resistance-coupled amplifier, the usual fixed resistors can be used, although it is well to try different values for best results.

—CHARLES GOLENPAUL

**Socket Antenna Becoming
Increasingly Popular**

DUE to the vastly augmented power of broadcasting stations, the replacement of the regenerative circuit by the tuned-high-frequency amplifier, and the greatly increased amplification of the average receiver of to-day, the socket antenna is now coming into favor, especially in congested areas.

In principle, the socket antenna is a coupling device that permits radio signals, induced in the electric light line, to pass through a special plug and into the receiving set, while the lighting current itself is held back by a condenser barrier.

With former regenerative circuits this device did not always perform satisfactorily. To-day, however, with the non-regenerative receivers, or at least receivers in which regeneration is merely an accessory rather than the main means of gaining sensitivity and volume, this device performs surprisingly well. In the suburbs and rural sections it will often out-perform the usual antenna, because of the ideal antenna in the form of exposed electric light wires which it makes available.

—HARRY HOUCK

CARTER

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for CX 326
(type tubes)
90c each
and CX 327
(type tubes)
\$1.10 each

Use these A. C. Bakelite Adapters in converting your set. Again Carter leads and is just a little ahead. They are sturdy and make positive contacts. Furnished with long lead wires for your convenience in connecting.

Any dealer can supply.

In Canada: Carter Radio Co., Ltd., Toronto

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CHICAGO

**BIG RADIO
CATALOG**

From the
"Big, Friendly
Radio House"

NEW 1928 Book
Offers finest, newest well-known sets; parts, eliminators, accessories at lowest prices.

Dealers—
Write for this
Catalog!

**Western Radio
Manufacturing Company**

136 West Lake St. Dept. 52
CHICAGO, ILL.

Hints on Volume Control

THE cardinal principle in controlling volume is to begin as soon as possible in the receiving process. In other words, the nearer the antenna end that the control is put into effect the better the results and the simpler the control; and, conversely, the nearer the reproducer end, the more energy must be handled by the variable resistance.

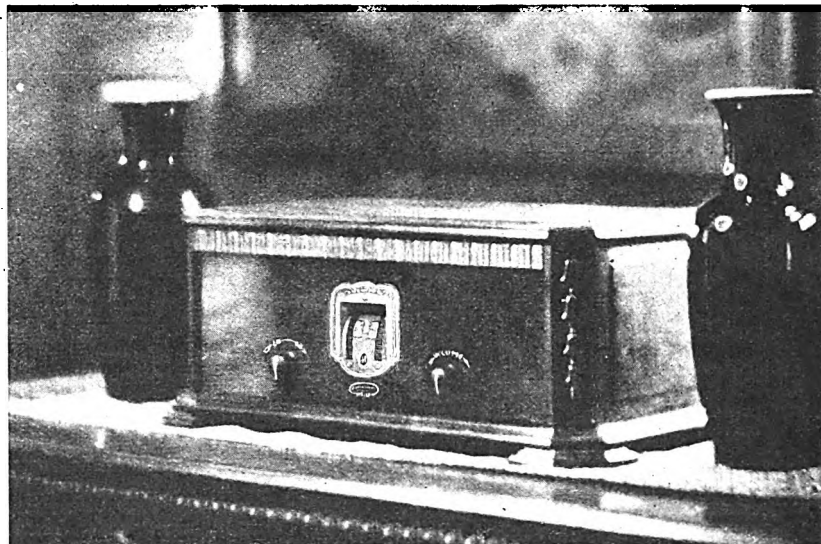
The simplest volume control is a variable high resistance in the antenna lead, which serves to cut down the signal energy, and is of real value, especially in the reception of powerful local stations. Sometimes the variable high resistance may be shunted across the antenna and ground binding posts of the set. At any rate, with a suitable variable resistor, such as the standard type Clarostat or the Clarostat volume control, a simple volume control is obtained for any receiver. The resistance range must be from practically zero to several million ohms.

Now if we do not control the energy at the entrance to the radio set, the next best expedient is to control it as soon as possible in the high-frequency stages. Here the best practice is to place the variable resistor in the 90-volt "B" positive (+) lead, so as to control the plate current of the high-frequency vacuum valves and therefore the energy passed on to the detector valve. The resistance must be of the order of practically zero to approximately 500,000 ohms.

With a volume control in the plate circuit of the high-frequency valves, it becomes possible to employ coils which will normally oscillate with 90 volts on the plates of the vacuum valves, with whatever stabilizing method may be used. Then, with a variable plate voltage, the receiver can be worked at top efficiency, right on the verge of oscillation, as well as brought down to a low efficiency in reducing volume without distortion. We have, therefore, a sensitivity as well as volume control.

If the set is of the regenerative variety, the regenerative action is the obvious thing to control, and this may be readily done without having to fuss with the critical tuning means, which can be left fixed at the desired point of maximum efficiency. The volume control may consist in this case of a variable resistor shunted across the terminals of the tickler or feed-back coil. Needless to say, the non-inductive type of resistor should be used. If desired, the set may be tuned with the variable resistor serving to by-pass more or less of the feed-back energy in getting down below the oscillating point with precision. This is a popular method of controlling regeneration, and likewise volume, especially in critical short-wave receivers.

—CHARLES GOLENPAUL



The advanced "Hi-Q SIX"—the greatest of all Hammarlund-Roberts Receivers—the culmination of years of concerted effort to produce radio's finest instrument, regardless of cost. As beautiful as it is efficient, yet costs only \$95.80 for complete approved parts!

This Perfect Receiver CUSTOM-BUILT for less than \$100

IMAGINE A CUSTOM-BUILT Receiver—designed by ten of America's leading manufacturers—incorporating latest modern constructional features and America's very finest parts—and costing you only \$95.80!

The new advanced "Hi-Q SIX" is more than a radio receiver—it is a marvelous musical instrument—a set that produces maximum and uniform amplification over the entire tuning range and that completely eliminates oscillation. These exclusive features—plus four isolated tuned stages—plus symphonic audio amplification and a power tube—result in the faithful reproduc-

tion of all musical frequencies with the full, natural tone quality that radio engineers have sought for years.

You can build the "Hi-Q SIX" yourself and save at least \$100.00. Simply get our complete Constructional Manual; buy the approved parts and our Foundation Unit, which contains chassis, shields, panels, all special hardware, etc. Manual contains 48 pages of construction data. Complete description, charts, diagrams and photos. Anyone can follow it and build the de luxe "Hi-Q SIX." 25c from your dealer or direct

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Hi-Q SIX**

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All material will be furnished you free of charge and you will be paid an attractive commission and salary. Mail coupon for full particulars.

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Celatsite Battery Cable

A rayon-covered cable of 5, 6, 7, 8 or 9 vari-colored Flexible Celatsite wires for connecting batteries or eliminator to set. Plainly tabbed; easy to connect. Gives set an orderly appearance.

Stranded Enameled Antenna



Best outdoor antenna you can buy. Seven strands of enameled copper wire. Presents maximum surface for reception, resists corrosion; this greatly improves the signal. Outside diameters equal to sizes 14 and 16. (We also offer solid and stranded bare, and stranded tinned antenna.)

Loop Antenna Wire

Sixty strands of No. 38 bare copper wire for flexibility, 5 strands of No. 36 phosphor bronze to prevent stretching. Green or brown silk covering; best loop wire possible to make.

Flexible Celatsite for sub-panel wiring



A cable of fine, tinned copper wires with non-inflammable Celatsite insulation. Ideal for sub-panel or point-to-point wiring. Strips easily, solders readily. Nine beautiful colors; sold only in 25 ft. coils, in cartons colored to match contents.

Acme Celatsite Wire



Tinned copper bus bar hook-up wire with non-inflammable Celatsite insulation, in 9 beautiful colors. Strips easily, solders readily, won't crack at bends. Sizes 14, 16, 18, 19; 30 inch lengths.

Spaghetti Tubing

Oil, moisture, acid proof; highly dielectric — used by leading engineers. Nine colors, for wire sizes 12 to 18; 30 inch lengths. (We also make tinned bus bar, round and square, in 2 and 2½ ft. lengths.)

Send for folder
THE ACME WIRE CO., Dept. P
New Haven, Conn.

ACME WIRE

MAKES BETTER RADIO

What's New in Radio

(Continued from page 146)

control adjustment. There are no auxiliary tuning knobs or levers and there are absolutely no other adjustments to be made.

At the top of the escutcheon plate is a window behind which the calibrated scale moves, showing the exact wavelength to which the receiver is tuned. A small incandescent lamp is mounted within the receiver in such a position that it illuminates the wavelength scale, which is of translucent material, thus making the wavelength settings easily readable, even in a darkened room.

The cabinet in which the receiver is mounted is of two-toned walnut, carefully blended to present a pleasing and dignified appearance. The front panel is of the same material as the rest of the cabinet and in its center bears the bronze escutcheon plate already mentioned. Flanking this plate on either side are two inset panels of darker-toned walnut, which successfully lend variety to the otherwise plain surface of the panel. The table-mounting cabinet shown above has overall dimensions of 19 inches by 10 inches by 8½ inches.

The circuit employed is the Tech-

nadyne circuit. This is a circuit which lends itself unusually well to compact construction, which explains how it is possible to make a 7-valve receiver with the dimensions given above. The receiver proper is shielded and the selectivity is unusual, partly as a result of this shielding and partly due to certain inherent characteristics of the circuit itself.

One of the unique features of the receiver is the fact that the volume control is neither a rheostat nor is it a variable high resistance. Instead it is a variable coupling arrangement which provides a smooth regulation of volume from inaudibility to maximum volume. This arrangement permits the use of any type of antenna and also makes for high efficiency on a short antenna.

As is usual with a receiver employing seven valves, this one is recommended for use with a suitable "B" power-pack or with "B" batteries of the heavy-duty type.

Outstanding features: Small size. Neat appearance. Highly selective. Smooth control of volume. Extremely simple to operate.

Maker: Homer Products, Inc.



A Light-Socket "A" and "B" Power-Pack

Name of instrument: Balkite model AB-135 power unit.

Description: This device is designed to supply both the "A" and "B" operating voltages for standard receivers which require not more than 2 amperes at 6 volts for the filament supply and not more than 40 milliamperes at 135 volts for the plate supply.

The "A" power portion of the unit consists of an electrolytic filter system and employs no batteries whatsoever. It does employ an alkaline solution in the filter which leads some fans to believe that it employs a storage battery-trickle charger combination. Such is not the case, however, as is proven by the fact that the unit furnishes no current when turned "off." The unit also draws no current from the AC lighting lines when turned "off."

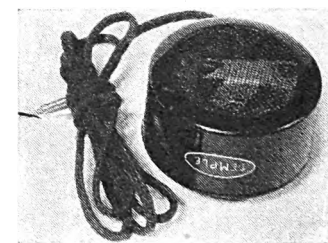
The "B" power portion employs an electrolytic rectifier with suitable filter. It will supply four different output voltages, namely, 22½, 67½, 90 or 135 volts, or by a simple adjustment the 22½-volt tap may be made to provide 45 volts if desired.

The entire combination is inclosed in a ventilated metal container with a removable cover. Once it has been put into operation, the cover may be placed in position and not removed, except for an occasional inspection of the water level in the "A" and "B" portion of the unit. Additional water is required two or three times

a year; this is the only attention required by the device. It is equipped with an extension cord and plug and also a toggle switch, by means of which the power is turned "on" and "off." This switch operates both the power-pack and the receiver. The switch on the receiver with which the device is to be used is therefore left "on" at all times.

Outstanding features: Compact. Obtainable in various types, for use on 110-volt, 60-cycle lighting lines, or on 220-volt, 60-cycle lighting lines, or 110-volt, 25-cycle lighting lines. Completely inclosed. Fool-proof. Employs no batteries.

Maker: Fansteel Products Co., Inc.



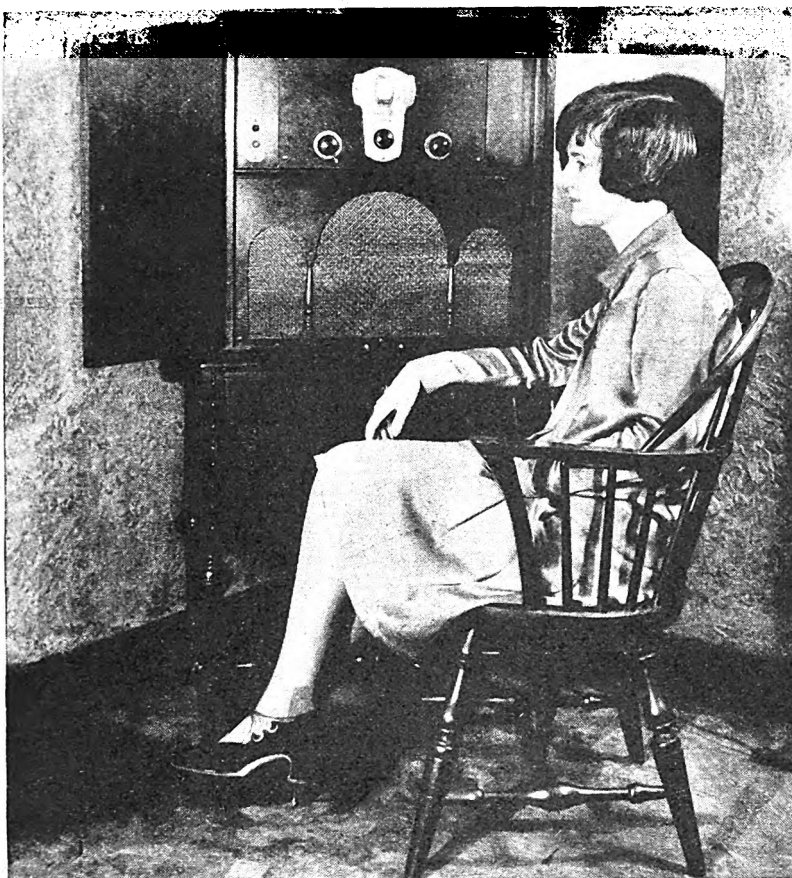
A Reproducer Unit for the New Exponential Horns

Name of instrument: Double-action reproducer unit.

Description: This new unit is especially designed to reproduce all tone frequencies in proper proportion to provide a natural reproduction of music and speech. It has a double-action mechanism and is completely inclosed to protect it from injury. In order not to interfere with reproduction of the higher frequencies, the case of the instrument is open at the back, but is protected with screening. It is equipped with an 8-foot extension cord.

Outstanding features: Especially designed for use with the larger exponential-type horn reproducers. Good quality of reproduction. Handles large volume without rattling.

Maker: Temple, Inc.



A Receiver That Features Tremendous Volume with Superlative Quality of Reproduction

Name of instrument: Kolster model 6-H receiver, with Kolster model "A" power cone reproducer unit.

Description: The accompanying picture will convey a good idea of the appearance of this combination receiver and power amplifier, although no illustration can really do justice to the soft beauty of the finish and the refinements of the cabinet maker's art incorporated in this receiver.

The receiver proper consists of three stages of tuned-high-frequency amplification, a detector and two stages of low-frequency in which are employed transformers of special design. The high-frequency amplifier circuit is one for which the Kolster receivers are justly famous wherever radio is known. It combines extreme sensitivity with the maximum permissible selectivity and yet is simple to operate and tune. The wavelength tuning is accomplished by means of a single knob which is mounted on the front panel of the receiver. To the right of this is another knob which provides a highly flexible control of volume. At the left is a third knob, which serves as a sensitivity control. This control is particularly useful when tuning for distant stations, as it permits exact tuning of the antenna circuit. This and a small lever set just beneath this knob provide the means for adapting the receiver to any antenna, thus permitting full efficiency, which could otherwise not be obtained when using a single control knob to tune all circuits simultaneously.

The output of the receiver proper provides the input for the power cone, which is mounted in the compartment immediately below the receiver compartment. The power cone unit consists of a special cone reproducer mounted on a chassis, which

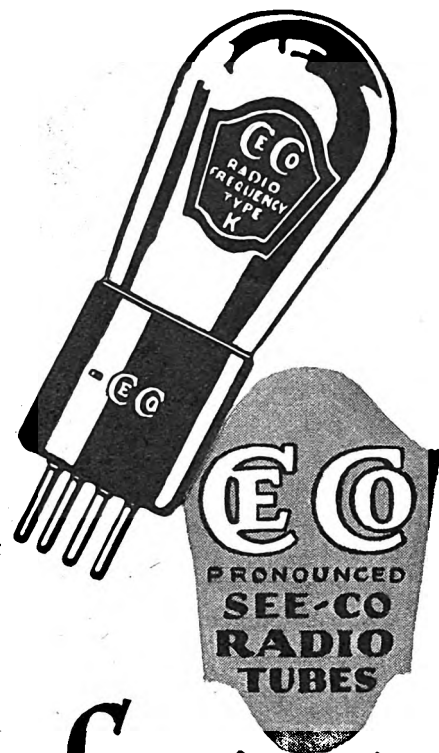
also mounts a complete high voltage power-pack that provides all "B" and "C" voltages not only for the receiver, but for the single stage of power amplification contained in the power cone unit. This stage of power amplification employs a 210 type power valve and, together with the low-frequency amplifier in the receiver, provides a wealth of undistorted volume with great fidelity.

The power-pack employs two rectifier valves of the 216-b or 281 types in a full wave rectifier circuit. This not only provides an abundance of power, but tends to eliminate all traces of hum. A voltage regulator valve is also incorporated in the power-pack to maintain constant voltages.

The receiver is turned "on" and "off" by the volume control knob, which really operates a combination volume control and battery switch. The AC supply to the power cone, from the house lighting lines, is controlled by a switch mounted on a panel at one end of the receiver proper. This push-pull type power switch is surmounted by a colored window, behind which a pilot light is mounted.

The filament supply current for the receiver is obtained from a combination storage battery and trickle charger or an "A" power-pack; this represents the only part of the equipment not included with the receiver. A compartment is provided for the "A" supply unit that may be selected. This compartment is in the cabinet below the one provided for the power cone.

The compartment at the top, in which the receiver proper is mounted, opens from the top to permit easy access for the installation of valves and for the connection of the ground and antenna leads to the binding



Sensitivity

- power-tone reproduction - unsurpassed volume -

all these and more in the

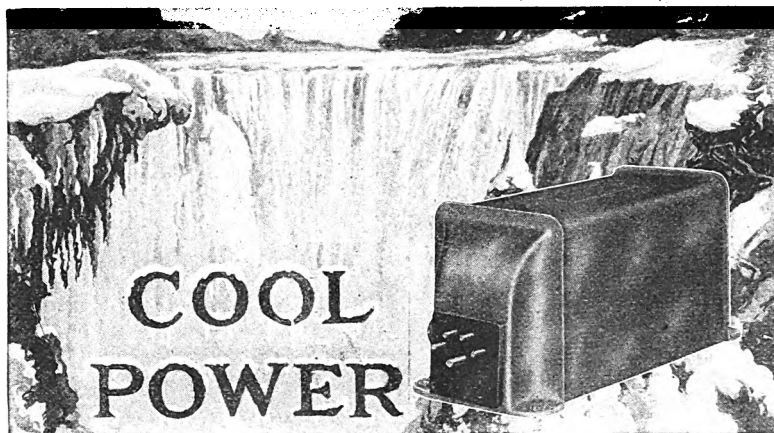
ECCO RADIO TUBE

Hammarlund-Lynch "Five" Receiver and National Power Amplifiers described in this issue specify CeCo tubes.

Write for interesting and rather unusual folder in regard to our entire line of CeCo Tubes.

The Largest
EXCLUSIVE
Manufacturers
of Tubes in the
World

C-E-MFG. CO. Inc
PROVIDENCE, R.I.



SAMSON POWER BLOCK NO. 210
The only block which will supply 500 volts at 80 mils to two 210 tubes

Powerize with Samson Units for Best Results

For new SAMSON Power Units insure the best there is in radio current supply by

1. Doing away with hum, motor boating and poor voltage regulation.
2. Remaining so cool after 24 hours continuous operation under full load that they will be well within the 20° rise of temperature specified by the A. I. E. E.
3. Being designed to more than meet the specifications adopted by the National Board of Fire Underwriters.
4. Insuring safety against shock because of protected input and output terminals.
5. Insuring for all tubes the correct filament voltages specified by their manufacturers.
6. Compensating for lighting circuit voltage variation by the use of a special input plug and terminal block to which is attached a 6 ft. flexible rubber-covered connecting cord and plug.

Our Power Units bulletin descriptive of these is free for the asking. In addition, our construction bulletin on many different "B" Eliminators and Power Amplifiers will be sent upon receipt of ten cents in stamps to cover the mailing cost.

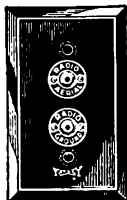
Samson Electric Co.

Manufacturers
Since 1882

Principal Office:
Canton, Mass.

YAXLEY
APPROVED RADIO PRODUCTS

Radio Convenience Outlets



**Wire Your Home
For Radio**

Enjoy your radio programs in any room in the house. Put the batteries in any out-of-the-way place. Bring aerial and ground connections to most convenient point. These outlets fit any standard switch box. Full instructions with each outlet.

No. 135—For Loud Speaker.....\$1.00
No. 137—For Battery Connections... 2.50
No. 136—For Aerial and Ground.... 1.00

Also furnished in two and three plate gang combinations.

WITH BAKELITE PLATES

Now furnished with a rich satin brown Bakelite plate, with beautiful markings to harmonize, at 25 cents extra. See Illustration.

At Your Dealer's

Yaxley Mfg. Co.

Dept. P-9, So. Clinton St., Chicago, Illinois

Your Radio CABINET



should receive some attention if you wish to preserve or restore its original beauty.

Atmospheric conditions cause the finish to check and lose its lustre, and soon a once beautiful instrument becomes faded and ordinary.

VARNITE RADIO POLISH

is a scientific compound, designed especially for Radio Cabinets, Phonographs and wherever a superior polish and restorative is required.

It restores the grain of the wood to its original beauty, preserves the finish and prevents checking.

Use VARNITE to clean the panel on your Radio, it will prevent "blooming" and that "foggy" appearance.

It is easily applied and leaves no greasy surface to collect dust. Sold by leading radio dealers everywhere or by mail postpaid.

Insist on the genuine, there is no substitute for VARNITE

Price: 50 cents

Manufactured and guaranteed by
DAVIS CHEMICAL COMPANY
93 Massachusetts Ave. Boston, Mass.

posts provided at one end of the receiver chassis.

Not the least notable feature of this receiver is the special "floating" mounting provided for the power cone. The entire power cone chassis, including the power-pack, is suspended on rubber cushions. This eliminates any tendency toward microphonic howling which might otherwise be encountered where a powerful reproducer such as this one is mounted in the same console with the receiver. The detector and first low-frequency valves are also cushion mounted for this same purpose.

Outstanding features: Fine tone quality and a happy combination of extreme sensitivity with correspondingly great selectivity. Single control tuning. Full control of volume. Special sensitivity control for long distance reception. Unusual volume, without distortion, obtained through the use of the power cone with a stage of power amplification.

Maker: Federal-Brandes, Inc.



A Filter Condenser That Is Easy to Mount

Name of instrument: Filter condenser.

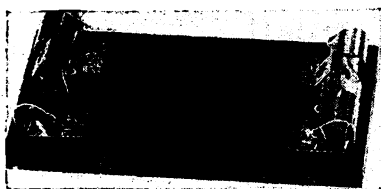
Description: Pure linen paper, a high grade of tin foil and special impregnation wax are the materials that go into this condenser. After the alternate layers of paper and tin foil are rolled into final form the moisture is carefully removed and the condenser is impregnated with wax. The assembly is then given a coating of moisture-proof wax pitch as a double protection against the absorption of moisture. The condenser is sealed in a metal can. The terminals of the condenser are flexible leads which are brought out through an insulating strip near the bottom of the can. The bottom of the can extends out a short distance on either side to provide mounting holes. This type of condenser is obtainable for different working voltages from 200 to 1000 DC, and in capacities from .1 mfd. to 10 mfd.

Usage: Wherever high-capacity condensers are required in high-voltage circuits, particularly for the filter in "B" power-packs.

Outstanding features: Carefully made of

good materials. Accurately rated as to capacity and conservatively rated as to voltages allowable. Well protected against the effects of moisture by a special wax impregnation.

Maker: Aerovox Wireless Corp.



Automatic Filament Supply for Old Receivers

Name of instrument: Amperite adapter system.

Description: The adapter consists of a composition base with accommodations for mounting two amperites in parallel, with two spring terminals for the wire connections. It is for use in conjunction with an old receiver which employs hand-operated rheostats to control the valve filament supply. With this adapter connected between the "A" battery and the receiver, the rheostats in the receiver may be turned up all the way and will require no further attention, as the amperites, when used in the proper combination, will provide just the right voltages for all valves. This system is not for use where one of the rheostats serves as a volume control, because it is imperative that all rheostats in the receiver be turned up full for proper operation. By choosing the correct amperites for use with these adapters, valves may be grouped in series, with one adapter to control their filament current. However, best results are obtained using one adapter for each valve in the circuit.

Outstanding features: Provides automatic filament control for receivers which are not so equipped. Prevents overloading of valve filaments, thus prolonging the life of the valves.

Maker: Radiall Company.



A "B" Power-Pack with Adjustable Plate Voltages

Name of instrument: Duo-Power model 28-A "B" power-pack.

Description: This is a power-pack that offers a number of good features. It provides six output voltages, from 22 to 180 volts, and is equipped with a rheostat in the input circuit to the power transformer, which permits the unit to be adjusted to supply maximum output voltages of either 135 or 180 volts. Thus the high-voltage output may be regulated to accommodate the power valve used in the receiver, and the five intermediate voltages are obtainable for the detector, high-frequency and first low-frequency valves. The unit employs a QRS gaseous rectifier valve and is

Increased Amplification by simple change in valves



Exact size photograph of the new Donle-Bristol DA-2 amplifying valve. Price \$3.00 each.

This new 6-volt amplifying valve is the latest production of Harold P. Donle, inventor of the already-famous sodion detector valve.

The Donle-Bristol DA-2 has a new type of oxide-coated filament, producing a much higher emission. It is used successfully in the high frequency amplifier of any standard DC set, with no changes of any kind in the circuit.

Each valve used increases the amplification from 30 to 50%—a gain at least equal to that which would be secured by an additional radio stage.

Complete characteristics will be mailed upon request, and if your dealer has not yet secured his stock, mail orders will be promptly filled by the manufacturers.

THE DONLE-BRISTOL CORPORATION
MERIDEN, CONNECTICUT

Distortionless Amplification



Type 373
Double Impedance Coupler
Price\$6.50

Somewhat better quality may be obtained by the use of impedance coupling than by the usual transformer coupling if one is willing to sacrifice the gain in amplification per stage. The type 373 Double Impedance Coupler incorporates two chokes and a coupling condenser, thus making a unit that may be substituted for a transformer without rewiring. With the exception of a slight drop between 60 and 100 cycles, the type 373 unit produces a perfectly flat amplification curve between 60 and 10,000 cycles.

Your community set builder can easily convert your present receiver to the 1928 Standards in case you do not care to undertake it—go to him—he is prepared to serve you.

GENERAL RADIO

GENERAL RADIO CO.

CAMBRIDGE, MASS.

Hammarlund
ROBERTS
Hi-Q SIX

SALES—SERVICE

BUY your Hammarlund-Roberts Hi-Q Custom made receiver from the Hi-Q Service Station. Construction information and help cheerfully given.

With the aid of the RTM Service Station your success is assured.

Receivers made to order at reasonable rates.

All parts in Stock.

Write for circular

Rossiter,
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Consulting Radio Engineers

136 Liberty Street, New York

Radio RTM Service

PRECISION ANNOUNCES



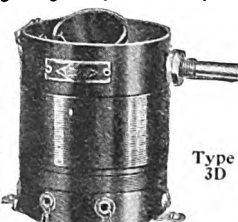
Type 4F

A Tuned R. F. Transformer with Tapped Primary (.00035 Condenser)

Here is another need supplied. Accurate to 1% of the rated inductance. Space wound on bakelite tubing, assuring you the best possible coil. Type 4F. Price \$2.50.

A 3-Circuit Tuner for a .00035 Condenser

A new coil you've been looking for—PRECISION again gives you what you have wanted but have been unable to get. Made with the same accuracy as the other Precision Diamond Cut Coils. Type 3D. Price \$3.75.



Type 3D

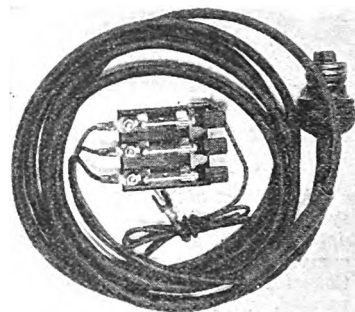
PRECISION COIL CO., Inc.
209 CENTRE ST. NEW YORK, N. Y.

TWO NEW DIAMOND CUT COILS

completely inclosed within a ventilated metal case. It is provided with an extension cord and plug to make connection with the 110-volt, 60-cycle lighting lines.

Outstanding features: Adjustable to the proper "B" voltages required by any receiver. Compact.

Maker: R. C. E. Sales Co.



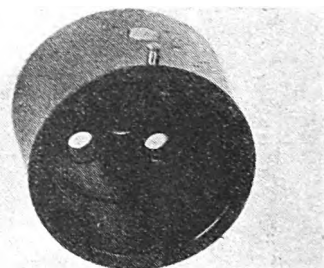
A Novel Socket Antenna

Name of instrument: "Sock-Antenna."

Description: This device consists of a multi-wire cable which terminates at one end in a standard plug for insertion in the light socket, and at the other end in a group of three single-pole, single-throw switches. The output sides of the three switches are connected together and a wire is provided for connection from this point to the receiver. The purpose of the device is to permit the use of the electric light supply lines for an antenna. This is accomplished through capacity coupling within the cable and the coupling is varied to fit the individual requirements of any receiver or any location by closing one, two or three of the switches.

Outstanding features: Permits the use of the light socket for an antenna. Entirely safe. Effectiveness of this antenna may be varied by means of the three switches.

Maker: Tidmarsh's Radio Supply.



A Handy Valve Adapter

Name of instrument: Valve adapter.

Description: This adapter consists of a composition cup with four holes in the bottom to accommodate the prongs of a UX-199 type valve. There is a set screw in the adapter by means of which it is firmly clamped on to the base of the valve. It is also equipped with a pin on the side to correspond with those on UX-201-a type valves. Thus, when this adapter has been placed over the base of a UX-199 valve such a valve may be used in any of the old sockets.

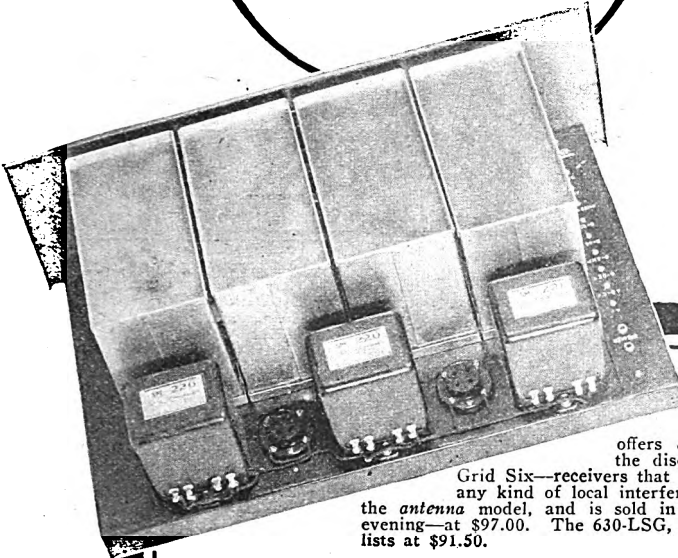
Usage: Where it is desired to use UX-199 or UX-120 valves in a receiver that is equipped with the old standard 5-volt valve sockets.

Outstanding features: Well made. Simple. **Maker:** Herbert H. Frost, Inc.

SM

New!

Shielded Grid Six



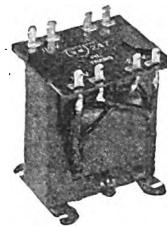
Do you realize that for less than \$100 for parts you can now build yourself a receiver that will out-perform anything the market offers at any price? Silver-Marshall now offers to the discriminating buyer two models of the Shielded Grid Six—receivers that for distance, tone and an ability to break through any kind of local interference have never been equalled. The 630-SG is the antenna model, and is sold in complete kit form—ready to be wired in one evening—at \$97.00. The 630-LSG, the popular and generally preferred loop model lists at \$91.50.

From Los Angeles in a driving California rainstorm—with terrific static and interference from power lines, the Shielded Grid Six brought in 2BL, Sydney, Australia, on the loud speaker. From Kansas City, without an antenna of any kind, the Shielded Six brought in stations from both the east and west coasts. Where can performance like this be equalled and at such a low price!

The Shielded Grid Sixes are easy to tune—they are receivers for the whole family—nothing “tricky” anywhere. Turning the two dials will bring in a new station on practically every dial degree—no repeats anywhere—and with powerful locals never spreading over from 2 to 4 dial degrees. Stations one, two and three thousand miles away will literally pour in—and with an ease that is amazing.

And remember—S-M unconditionally guarantees that you'll get more genuine satisfaction out of the Shielded Grid Six than out of any other set you can build or buy—whether you're a DX hound or a lover of fine tone.

“A” batteries filament transformer to your which enables angle change to any 5, 6 or 7 positive, sure filament transformer, 1.5 volts w/ 227 A. C. detector tubes. You apters or A. C. tube equipped set.



d Amplifiers

finest in tone quality. Each model has its own A, B and C power plant

JX-210 power tubes with an undistorted times clearer than that of ordinary and with at least one stage of audio you can get from any other power amplifier tubes and a UX-874 voltage KIT \$83.25, or 681-210 WIRED stage amplifier for phonograph or tube and the S-M 220 transformer.

SILVER-MARSHALL, Inc.
844 West Jackson Blvd., Chicago

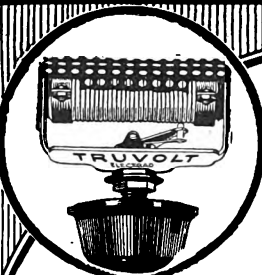
I enclose 10c for which please send me full information on quality audio amplification, power supply equipments, Unipacs, the new Shielded Grid Sixes and Universal All Wave Tuners.

☐ I enclose 25c for complete instructions and blueprints for the Shielded Grid Sixes.
☐ I enclose 25c for instructions and blueprints for building the All Wave Tuners.

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**Build
Eliminators
with**

TRUVOLT RESISTANCES

If you are building a B-Eliminator or an A. C. Set, use Truvolt all-wire variable and fixed resistances for permanent, accurate control. Prominent engineers are specifying Truvolt for power devices of their design. The unique design of Truvolt adapts it specially for B Eliminators and power devices. Due to maximum heat radiation surface, this unit develops less heat, resulting in longer life with unchanging accuracy.

A full line of Variable, Fixed and Tapped Wire-Wound Resistances for All Radio Purposes.

Write for Complete Free Truvolt Resistance Circular.

Dept. 18D, 175 Varick St., N. Y.

ELECTRAD



The BEGINNER IN RADIO

CONDUCTED BY ARMSTRONG PERRY

How to Learn the International Morse Code in Half an Hour

Scout Executive C. B. Stanford of Lancaster, Pennsylvania, has pictured the International Morse Code so that it sticks in the memory as easily as it used to escape. His picturization of the code is shown below.

This is the code that is used for sending radio messages. It is employed also in signaling with flags, whistles, bugles, buzzers, lights, heliographs and other apparatus.

No one can secure a license for operating an amateur or professional radio transmitter until he is able to send and receive this code at the rate of at least ten words per minute, so it is well to ac-

quire a working knowledge of the code.

Mr. Sanford has taught the code to hundreds at a time by broadcasting a description of the pictures and asking the listeners to draw them. Half an hour usually is sufficient for learning it.

Copies of the code for distribution to troops of Scouts and other groups may be secured at cost by writing to Delaware and Montgomery Counties Boy Scouts of America, Philadelphia, Penn.

* *

The Realm of the Short-Wave Receiver

THE beginner in radio may as well begin in the field that promises the best results. Just now that seems to be short waves, under 100 meters.

FERRANTI

Audio Frequency Transformers

2 TYPE AF-3

Give more and better amplification than any other audio combination

operating under identical conditions with standard equipment

Ferranti stands behind this claim of superiority. Try this quality transformer. Compare it with others, and you will be convinced of its outstanding merit. For volume, quality and range of reproduction you have never heard its equal.

Specified for Popular Hook-Ups

B1 Choke, for Vitrohm D. C. Eliminator, \$10.00

Type AF-4, for Magnaformer Circuit \$8.50

Push-Pull Units for Vitrohm D.C. Eliminator

90 Volt Power Amplifier

Type AF-4C, Input.....\$9.00

Type OF-7C, Output..... 9.00

Send for complete data on 90 volt D. C. power amplifier, giving volume and quality equal to 180 volt amplifiers on A. C.

New Type AF-5 Transformer.....\$14.00

Type AF-3 Transformer..... 12.00

Bulletins 1 to 13 give helpful information on better audio amplification, along with prices and detail on other Ferranti Transformers, not listed here. Send for it. There is no charge.

FERRANTI, Inc.

130 West 42nd St., New York, N. Y.

FERRANTI ELECTRIC, Ltd.
Toronto, Ontario, Canada

FERRANTI, Ltd.
Hollinwood, England

By remembering these comic pictures which the letters of the alphabet suggest, it is quite easy to learn the code in short order. If these pictures don't help you, make up a set of your own.

The broadcasting wavelengths are hopelessly crowded. The wavelengths from 600 meters up are used for commercial and government traffic; in that region the necessary separation is so great that it would be futile to move up the broadcasting band even if America had all of it instead of being under obligation to share it with other nations. Only a few stations could be accommodated in the higher wavebands. There is nowhere for broadcasting to go but down—or out!

At the beginning of the broadcasting era the amateurs were among the few men available to operate stations and design and build apparatus. Amateurs develop rapidly because they are free to experiment, while professional radio men are tied down to the details of their regular jobs. If the broadcasting stations enter the shorter wavebands, where there is room for thousands, the amateurs again will be in a position to fill some very good jobs. A few already have had experience in short-wave transmission and reception.

There are good short-wave receivers on the market. These will pick up a number of broadcasting stations that are experimenting with short waves; also they will bring in no end of amateur code traffic. A short-wave receiver can be built without great expense. Fifty dollars will cover the cost, because the number of parts must be reduced to the minimum, and there seldom is more than one stage of audio-frequency amplification. Such receivers cover tremendous distances. American amateurs maintain two-way communication with Australia—direct, not through relays.

It is worth while to read up on short waves, build or buy a receiver, plan for a transmitter and get into the amateur game.

* *

Adventures of Radio Operators

THRILLING tales of achievement and adventure could be told by John B. Duffy, superintendent of the Eastern Marine Division of the Radio Corporation of America. Every day he sends a dozen young operators off on voyages to distant ports. Some never return, and Mr. Duffy has to break sad news of shipwreck and death to parents and sweethearts. But usually the operators come back full of yarns to spin.

Mr. Duffy took up radio in its early days. From operators' jobs on tankers and passenger ships he rose to a chief's position at a coastal station of the R. C. A. Someone was needed for an important mission to South America, involving a large sum of money. Duffy was chosen. He succeeded, and now he is a superintendent.

Edward Adler joined the navy at fif-

ELECTRIFY WITH THE NEW A.C. TUBES

*Surprisingly Simple
Surprisingly Clear*

Na-ald A.C. Connector-Alds make it easy and simple to use the new A.C. tubes in the most popular battery-operated sets.

NA-ALD Connector-Alds bring the A.C. current to the filaments of the tubes and provide the proper compensators and circuits so that the operation is surprisingly clear, surprisingly free from hum and the volume is excellent.

Directions are packed with each adapter, and standard harnesses are made for the following:

Atwater-Kent No. 30-32 and 35, Crosley Bandbox Kolster, Radiola 16 and nearly all other sets.

Any set can be easily converted, using Na-ald harnesses with Na-ald Connector-Alds, Na-ald volume control, any good filament transformer and your present B Eliminator.

Kit No. 905 for 5 tube sets \$9.00

Kit No. 906 for 6 tube sets \$10.00

Kit No. 907 for 7 tube sets \$11.00

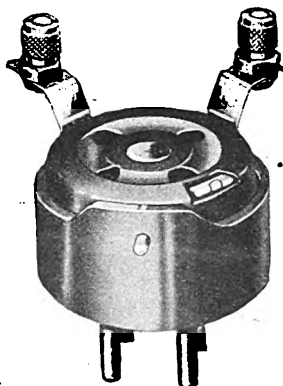
NA-ALD No. 601 series volume control \$3.00

NA-ALD No. 602 Potentiometer type Volume Control \$3.00

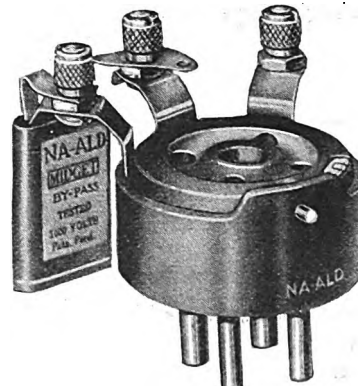
(Resistors R500 to 1000 may be needed in RF stages, see Na-ald A.C. booklet for particulars.)

This equipment does not require mid taps on transformers or any external resistances. It is self-contained. The connecting wires should be of No. 16 wire.

*See your dealer or write to-day for
the complete story.*



926



926GT

(See other pages of this magazine for particulars of Na-ald, new A.C. sockets.)

Write for Na-ald A.C. Booklet

ALDEN MFG. CO. Dept. C4. Springfield, Mass.

RADIO PROBLEMS SOLVED

It is possible that your individual problem has been covered in an issue of POPULAR RADIO, and so as an aid to you we endeavor to keep a supply of back numbers in stock. The condensed index below gives a few of the subjects that have appeared recently; look this list over and if the information you want is covered, we will be pleased to supply back numbers at 35c a copy.

October, 1926

- How to Build the New LC-27 Receiver.
- The Radio Road Hog.
- POPULAR RADIO Circuits.
- Sets That Earn Incomes.
- Inside Information on New Radio Receivers.
- Why Signals Fade.

November, 1926

- How to Build the LC-Senior Power-Pack.
- Waves and Wavelengths.
- POPULAR RADIO Circuits.
- How to Select Your Radio Parts.
- How to Patent Your Radio Inventions.
- How to Solder.

December, 1926

- Uncle Sam's New Short-Wave Net.
- How Circuit Resistance Affects Selectivity.
- POPULAR RADIO Circuits.
- How to Build the LC-Intermediate Power-Pack.
- Inside Information on New Radio Receivers.

January, 1927

- How to Build the New KH-27 Receiver.
- To Start and Stop Your Set Automatically.
- POPULAR RADIO Circuits.
- The Quack Doctors of Radio.
- How to Build the LC Junior Power-Pack.

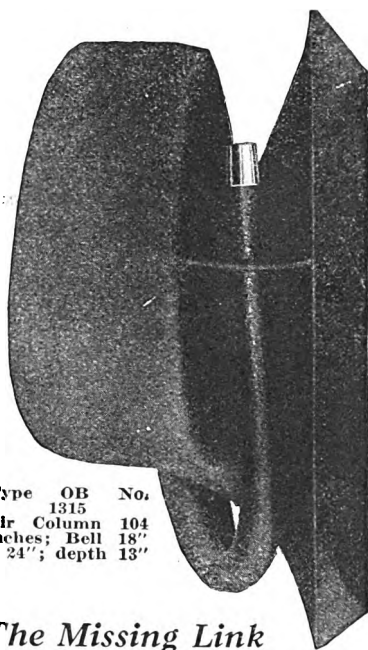
POPULAR RADIO

119 West 57th Street

New York, N. Y.

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RACON Exponential Horns



Type OB No.
1315
Air Column 104
Inches; Bell 18"
x 24"; depth 13"

The Missing Link

between Perfect and Faulty Reproduction. Because Racon Horns are made of an exclusive nonvibrating material.

The RACON Process assures uniformity; strength; maximum quality; minimum weight.

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RACON ELECTRIC COMPANY, Inc.
18-24 Washington Pl. New York, N. Y.

Send for Your Big! New! Catalog! It's Free!

Contains all nationally known parts and kits

Teletrol Kits
New Lc-28
Lc-28 Unipac
Magnaformer
Hammarlund Roberts Hi-Q6
Aero Seven
World's Record Ten
Melo Heald 14
Silver Marshall Parts
Zetka Tubes
and others

**S. HAMMER
RADIO CO.**

303 Atkins Ave., Brooklyn, N. Y.

teen. After six months' training, he visited Turkey, Italy, France, Russia, the Balkans and every important port in the West Indies as radio operator on *U. S. S. Arizona*. He was transferred to the Naval Communication Service, in Washington, where the men with whom he worked were experts. He decided to make his sign, AC, stand for Ability. A year of hard work and study made him as good as any of them.

One evening in Yokohama harbor, Japan, he was on watch in the radio cabin of *U. S. S. Huron*. The crew were seeing movies on deck. Suddenly there came a terrific crash. The city quivered, the houses fell and flames shot heavenward. An earthquake had passed, leaving the city in ruins. The *Huron* was the flagship of the Pacific fleet. She had the only high-powered radio apparatus available in the whole region. Adler transmitted the admiral's orders to establish relays of American destroyers to handle the calls for help, and had the pleasure of seeing the relief ships come into port in response to his messages, with food, medicine and other supplies that saved many lives.

In 1926, while serving as an operator for the R. C. A., he won the world's speed championship by receiving fifty-eight words per minute by ear.

E. N. Pickerill once operated the highest telegraph station in the world, on Pike's Peak. He has been an operator on many ships, at a transoceanic station

in Honolulu, and on many airplanes. He earned the first "extra first-grade" operator's license ever issued.

When the *Leviathan*, the world's largest and finest ship, went into commission under the Stars and Stripes, "Pick" won his berth on her in the hardest examination ever given to a host of applicants for an operator's job. He has crossed the ocean in her a hundred times and his souvenirs include autographed photographs and other gifts from scores of her famous passengers.

* *

A Radio Amateur Advertises His City

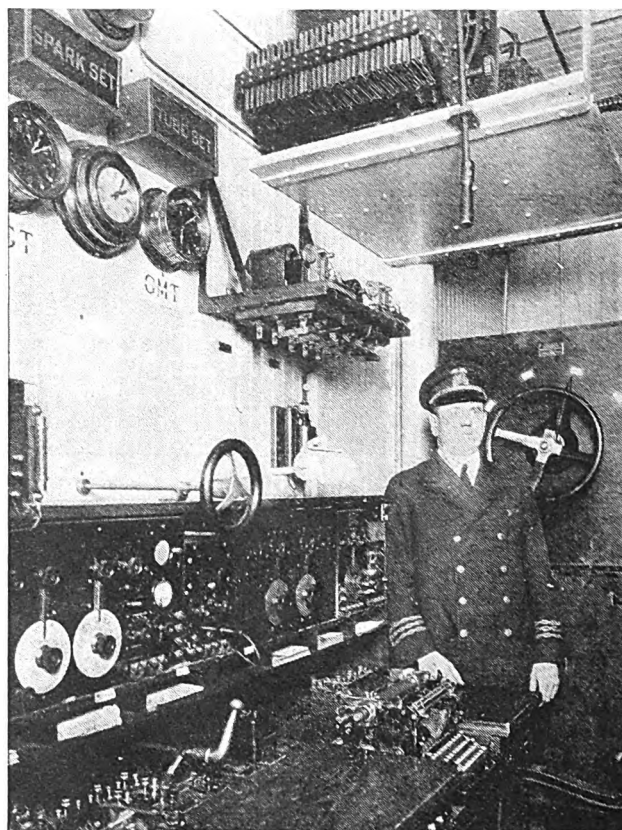
AMATEUR 1-AMU, whose name was Franklin B. Rowell before he became wedded to radio and exchanged his name for call letters, saved a printing bill and helped his city by making the Chamber of Commerce in Pawtucket, Rhode Island, this offer:

If the Chamber would supply him with "QSL" cards, they could print on them the city's slogan, a picture of some historic building, and a credit line.

The Chamber accepted the offer. The card reads:

"Pawtucket, Rhode Island. The Birthplace of the Cotton Industry.
1-AMU

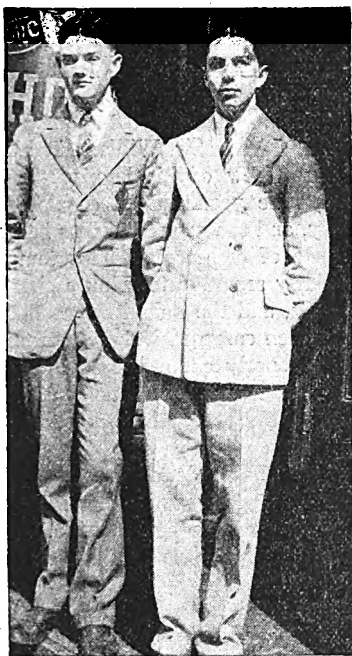
Courtesy of Pawtucket Chamber of Commerce. Radio..... I was v'y gld to wrk U on..... at E.S.T. U were R..... hr. with a..... QSB on the..... meter band. Receiver Reinartz one step. Transmitter Hartley Crkt.... Watts Input. Heitz Ant. Remarks.....



Radio Corporation of America

THE MOST COVETED OF RADIO OPERATORS' JOBS

Here is E. N. Pickerill in the radio room of the *LEVIATHAN*—the best equipped radio room on any American vessel. He was placed in charge after passing the hardest radio examination ever given in this country.



TWO CHAMPIONS IN THE AMATEUR WORLD

Franklin B. Rowell, at the right, devised the unique scheme of getting the Chamber of Commerce of his home town to pay for his QSL cards in return for free advertisement. He also sent an amateur radiogram to the Philippines and located a missionary from China whose American friends were worried about. At the left is W. R. Pierce, who reports that he has logged 625 broadcasting stations in 38 countries with a 2-valve receiver and that he has cards and letters to prove it.

A.R.R.L. O.R.S. O.B.S. R.C.C. DX World Wide.
Please QSL. Tnx vy. Army Amateur Station.
CUL. Best 73 OM."

For the benefit of the uninitiated, let us translate the radio lingo:

"I was very glad to exchange messages with you on.....at.....Eastern Standard Time. You were received here with a (fine, mushy, or what have you) tone on the.....meter band. Transmitter here has a Harley circuit with a power input of.....watts. Hertz antenna. I am a member of the American Radio Relay League and operate an official relay station and official broadcast station. My long-distance messages cover the earth. Please reply. Thanks, very. My station is an official station in the Army-Amateur Net. See you later. Best regards, Old Man."

"OM," the classic appellation of telegraphers, radio men and amateurs, does not apply to all, however. The girls are "YL's," not "OM's."

Rowell's claim to world-wide range is no idle boast. He advertises in the papers that he will send messages by amateur radio to any part of the world free of charge. Recently he sent a message to the Philippines for a woman whose friend, a missionary, had escaped from China to the Philippines. The missionary was located and an answer returned via amateur radio in ten days.

Rowell uses his "QSL" cards to report to amateur stations throughout the world that he has heard them.

If you feel inclined to doubt that the universe is in the hands of an all-wise creator, remember that the good radio weather starts about the time when the big college football games are broadcast.

30 DAYS FREE TRIAL

MAGNIFICENT TONE-SUPER SELECTIVE-POWERFUL DISTANCE GETTER

All Electric or Battery Set! Yes! Big Discounts to User-Agents

America's big, old, reliable Radio Corporation (8th successful year) guarantees in its big, powerful, latest 6, 7 and 8 tube Miraco sets the finest, most enjoyable performance obtainable in high grade radios. Unless 30 days' use in your home fully satisfies you a Miraco is unbeatable at any price for beautiful, clear cathedral tone, razor-edge selectivity, powerful distance reception, easy operation, etc.—don't buy it Your verdict final. Save or make lots of money on sets and equipment—write for testimony of nearby users and Amazing Special Factory Offer.

Miraco's work equally fine on "AC" electric house current or with batteries. Take your choice. Many thousands of Miraco users—who bought after thorough comparisons—enjoy programs Coast to Coast, Canada to Mexico, loud and clear—with the magnificent cathedral tone quality of costliest sets. Don't confuse Miraco's with cheap, "squawky" radios. Miraco's have finest parts, latest approved shielding, metal chassis, etc.—as used in many \$200 sets.

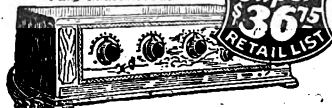
DEAL DIRECT WITH BIG FACTORY

Your Miraco reaches you completely assembled, rigidly tested, fully guaranteed. Easy to connect and operate. 30 days trial free. 3 year guarantee if you buy. You take no risk, you insure satisfaction, you enjoy rock-bottom money-saving prices by dealing direct with one of radio's oldest, most successful builders of fine sets. 8th successful year.

Dealers Write **USER-AGENTS!** Make big profits showing Miraco to friends. Get Our Special Wholesale Prices! MID-WEST RADIO CORPORATION, Cincinnati, O.

Free! **BEAUTIFULLY ILLUSTRATED CATALOG AND AMAZING SPECIAL OFFER** SEND NO MONEY—30 DAYS' TRIAL, Special Wholesale Price Offer to User-Agents, Bank References, testimony of nearby Miraco users—all the proof you want—sent with catalog. **mail coupon right now!**

ANOTHER BIG BARGAIN! Famous powerful big Miraco Super 6, 1925 model—ultra selective! Thousands find it out-performs sets of much higher price. 30 Days' Trial Free. Fully Guaranteed.



6 tube Super \$36.75 RETAIL LIST

MIRACO "Powerplus" sets—8 and 7 tube models—have magnificently beautiful, clear cathedral tone quality. Turn one dial for stations everywhere. Ultra-selective. Latest all-metal shielded chassis, illuminated dial, fully guaranteed. Try one free for 30 days! Big selection of beautiful cabinets.

7 tube one dial METAL SHIELDED CHASSIS \$49.75 RETAIL LIST

Electrify Any Radio with MIDWEST NO-BATTERY AC Light Socket Power Units

"A," "B," and "C" power, direct from light socket, without batteries! Write for Midwest prices and discounts. Units are highest grade—lastingly dependable, quiet in operation, fully guaranteed. Mail coupon.

MIDWEST RADIO CORP'N Pioneer Builders of Sets 49-C Miraco Bldg., Cincinnati, Ohio.

WITHOUT OBLIGATION, send me free literature, AMAZING SPECIAL WHOLESALE PRICE OFFER, testimony of nearby users, etc.

NAME _____ ADDRESS _____

THIS COUPON IS NOT AN ORDER

How to Make Money in Radio

In every village, town, hamlet and city in the United States readers of POPULAR RADIO are capitalizing their knowledge of the art and are making money quickly and easily. You, too, can build up spare time income in servicing or building radio receivers. In the February number of POPULAR RADIO, Charles A. Kennedy of Albany, Indiana, tells how he makes \$1200 a year in spare time, following his fascinating hobby of radio.

At the present time there are 50,000 professional set-builders in the United States and, by the end of 1928, there will be 75,000. Are you going to be one of them? Are you going to make money out of your fun?

Don't miss this inspiring article. Send your subscription today. A year's subscription to POPULAR RADIO is \$3.00.

Make all remittances to the Subscription Department.

POPULAR RADIO, INC.

119 WEST 57TH STREET

NEW YORK, N. Y.



HIGH IN PUBLIC FAVOR

In the air, where reliability is so vital, and in the home, where quality is all important, the Victoreen "Super" reigns supreme.

Once you have heard a Victoreen "Super" you will realize, better than words can tell, its greatly superior tone quality, selectivity and sensitivity. It is the simplest super to build, and you are sure of results.

Victoreen R. F. Transformers

The heart of the "Super" circuit. Matched and tuned to a precision of $\frac{1}{3}$ of one per cent. No. 170 for Storage Battery or AC tubes—No. 171 for Dry Battery tubes—each \$7.00.

Victoreen "112" Audio Transformer Unit

The newest and most highly perfected method of audio amplification. Combines the two stages in one case, using either two "112" tubes or a "112" tube in the first audio and a "210" tube in the second and up to 475 volts of "B" supply.

Produces the most marvelous tone quality you have ever heard—Price \$22.00.

You can build a Victoreen "Super" and be assured of quality results. Send today for free 1928 blueprints of the Victoreen Universal Circuit and the new AC circuit.

THE GEORGE W. WALKER CO.

Merchandisers of Victoreen Radio Products

2825 Chester Avenue Cleveland, Ohio

Victoreen

HIGH QUALITY RADIO PARTS

NOTICE PROFESSIONAL SET-BUILDERS

POPULAR RADIO is preparing special information which will be of great value to professional set-builders throughout the United States. Those who desire this information may have it, free of charge, by addressing a letter of inquiry to the Service Department and answering the following questions:

1. How many sets do you construct each year?
2. What receivers are you specializing in?
3. What do you spend for radio parts each year?
4. How long have you been in business?
5. Do you operate in full or spare time?

Address all inquiries to the Service Department,

POPULAR RADIO, INC.
119 WEST 57th STREET
NEW YORK, N. Y.

POPULAR RADIO 5 MONTHS FOR \$1.00

To double our list of subscribers, we will for a limited time accept \$1.00 as payment in full for a five months' subscription for POPULAR RADIO. This offer is open to new subscribers only. Tell your friends about it. They will appreciate this money-saving opportunity to secure POPULAR RADIO promptly and regularly each month.

The convenient coupon gives other attractive offers good for either new or renewal subscriptions.

POPULAR RADIO
119 West 57th Street
New York City

POPULAR RADIO, Dept. 17,
119 West 57th Street,
New York City.

Enclosed is remittance of \$..... payment in full for subscription order for POPULAR RADIO as checked below.

- ☐ 5 months for \$1.00 (new subscribers only).
☐ 7 months for \$1.25 (new subscribers only).

Name.....

Address.....

City..... State.....

Now You Can Be a "Looker-In"!

(Continued from page 124)

gas, neon, from Sir William Ramsay, to make a few of his lamps. Today neon can be produced in considerable quantity, and the neon lamp has become an article of commerce. This lamp is particularly sensitive to minute changes in current, and the light it gives fluctuates between comparatively wide ranges, if it is properly connected to a source of modulated current such as that which flows through it in the television receiver.

The photo-electric cells used in the present television transmitter are very large and exceptionally sensitive. This high sensitivity obviates the necessity of using exceptionally powerful beams of light for the scanning process. This has the advantage of subjecting the person to be broadcast to no undue discomfort or eye strain. As a matter of fact, these cells are so very sensitive that they are paralyzed if a match is struck closely to them. During the experiments at Schenectady, the person demonstrating the sensitiveness of the device to cigarette smoke had to take care not to light his cigarette within the range of the sensitive cells.

While it was stated at the beginning of this article that television was ready to receive the attention of broadcast fans, it must be understood that television is today in the same state of development that broadcast reception was six years ago. Television is really in the "earphone" period of development. This must not be taken to mean, however, that it is extremely crude; for it is not. Likenesses are immediately recognized and the photographic fidelity of the reproduction is simply amazing. Even the wink of an eye can immediately be discerned, and no movement by the person being broadcast can be too quick to escape the sensitive electric eyes that are being trained upon the object.

As a result of the announcement of this television device, newspaper writers have already indulged in the possibilities of receiving picture impressions of football games, prize fights, and the like. While there is no doubt that this development will eventually come about, the present equipment is not suited for this purpose. The objects that are to be transmitted must be scanned and explored with a rapidly moving beam of light, and the process must be carried out in a comparatively darkened room. If the objects to be broadcast were brilliantly illuminated with light of the same intensity as that being interrupted by the scanning disc, the photo-electric cells would receive a jumble of impressions, and it would be impossible to reproduce the likeness of the object at the receiver.

The receiver must, likewise, be used in a darkened room, since too much light has the same effect as it has today in the moving picture theater; the picture is dimmed, and if the light source is strong enough it will entirely fade from vision. The receiver is so arranged that the picture is reproduced in a chamber which is more or less guarded from the effects of an outside light source.

What will the effect of static be on the television receiver? Theoretically, a heavy discharge of static ought to increase the current flowing through the neon lamp, and this, in turn, should cause it for an instant to glow more brilliantly. Consequently, a heavy discharge of static should make its presence known by the appearance on the picture of an extra bright glow from the neon lamp.

An interesting example of television interference was witnessed during the demonstration at Schenectady, at which a dial telephone was employed in the same room. Dialing a number is always responsible for a certain amount of radio interference on broadcast receivers, and the engineers present watched carefully to see if the same effect was noticeable in the picture reception. It was. As the number was dialed, bright streaks swung across the picture at various spots. Perhaps the radio fan of tomorrow will come into the office in the morning, and instead of saying that static played havoc with the overture of "The Merry Wives of Windsor," he will lament the fact that it destroyed Al Jolson's face or Mary Garden's left ear.

Another unusual phenomenon observed at the demonstration in Schenectady was the presence of fine, hairlike black lines, spaced at regular intervals across the reproduced picture at the receiver. These imperfections were due to improper arrangement of the holes on the scanning disc at the transmitter. As a matter of fact, the arrangement of these holes is still one of the problems of television. It is evident that they cannot be arranged so that the beams will overlap. They must be exactly spaced to the hundred thousandth of an inch, or the reproduced image will suffer from distortion.

Within the next year, no doubt, broadcast fans throughout the United States will be building for themselves television receiving equipment. All of the devices used in reception are available and no great skill is necessary for the construction or the manipulation of the receiver. From time to time POPULAR RADIO will make known to its readers the various improvements in the art, and it is possible that within the next few months this publication will give the details of a practical working receiver that may be easily made by any broadcast fan.

Make your set a real deluxe A. C. electric

and get powerized amplification—

The finest tone quality

in radio - -

Now you can equip your radio with the same power and tone plant that is used only in the most expensive A. C. electric receivers. With the Powerizer you not only install A. C. tubes—eliminate all batteries—and separate eliminators—but also you secure Powerized amplification! The

POWERIZER

uses the UX-210 tube, the Rolls Royce of tone tubes. Only through Powerized amplification can you get that rich mellowness and depth of tone. Powerized amplification is the difference between the ordinary A. C. electric sets and the \$600 to \$1,000 Deluxe electrics . . . Only in Powerized sets—and Deluxe electrics do you get Powerized amplification. The Powerizer can be easily and quickly installed—no rewiring is required—for the Powerizer is equipped with harness and adaptors which hold the new A. C. tubes and set right in the sockets of your set.

Write for details how to make your set a 1928 A. C. electric receiver and get Powerized amplification—the finest tone quality in radio.

RADIO RECEPTOR CO.

106 Seventh Avenue, New York City

Licensed by RADIO CORPORATION OF AMERICA and Associated Companies

Model for Atwater-Kent and other standard sets.....\$60.00
Radiola "20" model without tubes 59.00
A. C. power and amplification pack especially designed for Radiola "25" and "28".. 84.00



Better Results from AC TUBES

Centralab Radiohm RX 100

A new taper of resistance specifically to control volume of receivers using the new AC tubes. A variable resistance in R. F. plate circuit or R. F. filament circuit, customarily used in battery circuits, cannot be used with AC tubes without destroying the delicate balance of voltage for efficient operation.

Centralab RX 100 Radiohm, with minimum capacity and smooth,

noiseless action, inserted in the grid circuit of one of the R. F. stages, does not affect the filament or plate potentials, insuring balance and eliminating a source of AC hum.

In "super" circuits, the most satisfactory volume control is obtained by inserting the RX 100 in the grid of the intermediate frequency that is not sharply tuned.

Also a 50 ohm Centralab Power Rheostat inserted in the primary of the transformer will compensate for any line fluctuation—increasing life of tubes and holding entire circuit at the point of best operating efficiency.

Centralab Heavy-Duty Potentiometer

A new improved positive voltage control for B-eliminators, insuring better tone. In any ordinary circuit this unit is burn-proof, warp-proof

and constant in resistance. It is all wirewound, and will carry entire output of any B power circuit. Resistance remains constant at any knob setting, so that panel

or knob can be marked in volts. Resistances 2,000, 3,000, 5,000, 6,000, 8,000, 9,000, 10,000, 15,000, 25,000, 50,000; price \$2.00, at your dealer's or C. O. D. Write for folder.

CENTRAL RADIO LABORATORIES
17 Keefe Ave., Milwaukee, Wis.

Centralab

Other products of Centralab are Radiohms, Modulators, Potentiometers, Power Rheostats, and Heavy Duty Potentiometers—Folder 328 describes them all. Write for it.

Build a Powerizer in 2 Hours

(Continued from page 128)

When all the connections have been checked, the unit is complete, and the unit is ready to be installed.

Applying the Powerizer to the Atwater Kent Model 35

First, obtain five special Na-ald adapters, including four No. 926 Na-ald Connectoralds and the one No. 927-UY Connectorald, and a five-lead Corwico cable, which consists of a yellow, a blue, a black, a red and a gray lead. The gray lead is not used. These should be connected up into a cable, as shown in Figure 2. The cable should be arranged so that each of the Connectoralds will fit in the sockets, starting at the left with the set turned upside down, as shown in Figure 1. This same diagram shows the connections for the 400-ohm volume control, the light socket antenna, the Racon reproducer and the unit itself. When the adapters have been placed in the sockets and the transfer plug has been placed in the last socket on the extreme right, the vacuum valves may be put in place in the receiver and in the power unit.

Place three CX-326 type valves in the first three adapters at the left and place a CX-327 type valve in the fourth adapter with a CX-326 type valve in the fifth adapter from the left. The transfer plug, as stated before, is placed in the sixth socket. Then place a CX-310 type valve in socket F of the powerizer and place a CX-381 type rectifier valve in socket E in the powerizer. Notice that the leads of the Corwico cable must be twisted the entire length to the binding posts of the unit. This is done by taking off the outer covering of the cable.

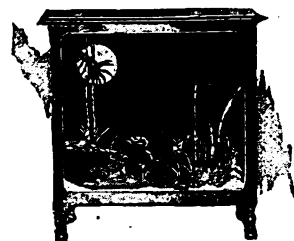
Next fasten the attachment plug of the power unit to the 110-volt AC lighting lines. A standard electrical plug should be used for this purpose.

The set is now ready to operate, except that the volume rheostat on the receiver will not be used, and the volume control will be done from the external 400-ohm resistance. The set operates, otherwise, the same as before.

If all of these instructions and suggestions are carried out carefully, the owner may be proud of a modern, up-to-the-minute AC-operated receiver.

The whole set will turn "on" and "off" at the electric socket. It must, however, be remembered that it takes about 40 seconds for the AC valves to heat up to the proper temperature before they begin to operate properly.

Readers who do not care to build this unit at home may obtain it completely assembled and inclosed in a metal container; it is sold under the trade name of Powerizer. The completed unit comes ready to install and includes the necessary Connectoralds and cable, ready cut.



The speaker complete in cabinet with velvet tapestry—24"x24" diaphragm \$65.00

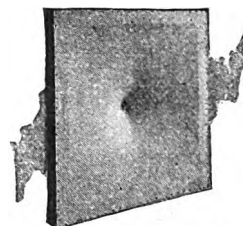
The Air-Chrome SPEAKER

is the new standard for loud speaker performance.

ALL MUSICAL INSTRUMENTS IN USE are within its range. . . .

This speaker represents a new field of loud speaker engineering.

Order from us or your dealer. If your dealer cannot supply, send us his name.



The speaker without cabinet 24"x24" diaphragm \$25.00

THE AIR-CHROME STUDIOS
168 Coit Street Irvington, N. J.

XL Products

Model "N" Vario-Denser

Pep up Your Set!

Easier tuning—correct tube oscillation—more volume and clearness with an X-L VARIO DENSER in your circuit.

Specified and endorsed by foremost radio authorities in all leading circuits.

MODEL "N"—Micrometer adjustment easily made, assures exact oscillation control in all tuned radio frequency circuits. Neutrodyne, Roberts 2-tube, Brownings-Drake, Silver's Knockout. Capacity range, 1.5 to 20 Mfd. Price, each, \$1.00.

MODEL "G"—Obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in superheterodyne and positive grid bias in all sets. Capacity range, Model G-1, .00002 to .0001 Mfd. Model G-5, .0001 to .0005 Mfd. Model G-10, .0005 to .001 Mfd. Price, each, with grid clips, \$1.50.

X-L PUSH POST—Push it down with your thumb, insert wire, remove pressure, wire is firmly held. Vibrations will not loosen, releases instantly. A push post that excels in appearance, action, service and convenience. Price, each, 15c.

PUSH POST PANEL—7 push posts mounted on black insulating panel with permanent white markings. Soldering lugs, raising bushings, screws for mounting, etc., in box complete. Price, \$1.50.

Investigate the Goodwin Aperiodic Detector Circuit. This is applicable to any set and adds a stage without added tuning controls.



X-L Push Post Panel

Free—New, up-to-date book of wiring diagrams showing use of X-L units in the new LOFTIN-WHITE constant coupled radio frequency circuit, and in other popular hook-ups. Send for yours today.

XL Radio Laboratories

2422 Lincoln Ave., Chicago, Ill.

A Radio "Echo" That 5,000 Heard

(Continued from page 134)

mediately in front of Colonel Lindbergh. A telephone line carried his voice from the airport to the broadcasting station, about a quarter mile distant. The broadcast from station WGY was then received on a high-grade radio receiving set at the airport, and the output amplified in the Victrola reproducing equipment. The mammoth horn, which is eight feet square at the mouth and contains special loudspeaker units, was located on a 15-foot scaffold, about twenty-five feet to the side of the speakers' stand, and was pointed directly at the crowd assembled in front of the stand.

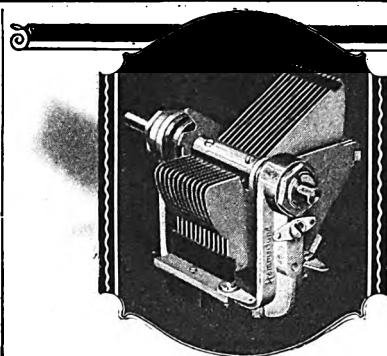
It seemed almost inconceivable, so natural and clear was the speaker's voice brought to the great crowd by this new apparatus, that radio transmission and reception had reached such a stage of perfection. Interference from static and line noises were not present; only the voice of the speech-maker was heard, and that hundreds of times louder than he himself was speaking.

Both before and after the ceremonies the crowd was entertained with phonograph records played directly on the Auditorium Orthophonic Victrola, which reproduces over the entire musical range and down to 30 cycles. Most appropriate to the occasion was the playing of the records which were recorded from the radio broadcasts when Lindbergh was received in Washington by President Coolidge, upon the former's return from Europe.

Direct radio receiving, and what might be called "indirect radio receiving" of this nature have possibilities which only the future can develop to their fullest extent.

A Unique Radio Census

AN interesting method of gauging the number of people who listen in on a radio broadcast was used recently by station WWNC at Asheville, N. C. The station offered prizes to those who estimated most accurately the number of persons within a one-hundred-mile circle of the station who listened in on the broadcasts. Entry blanks were published in the daily papers, and persons wishing to enter the contest clipped these blanks, filled in their estimate and mailed the blanks to the station. The blanks were also filled in with the contestant's address, model of receiver owned, and preferences in broadcast programs. When the blanks were checked up and counted, a fairly accurate census of the number of listeners was obtained. The prizes offered for the closest estimates were radio equipment and receivers.



**HAMMARLUND
"Midline"
CONDENSER**

Soldered brass plates with tie-bars; warplless aluminum alloy frame; ball bearings; bronze clock-spring pig-tail; full-floating, removable rotor shaft permits direct tandem coupling to other condensers. Made in all standard capacities.

WHENEVER quality results are required in a radio receiver, you may expect to find one or more Hammarlund Precision Products officially specified.

Hammarlund leadership has been attained, not through forced sales efforts, special deals, cut prices or any other of the so-called "tricks of the trade."

Just two things are responsible for the world-wide Hammarlund reputation and they are:—Determination to make the best and unmatched facilities for accomplishment.

Public recognition is the natural result.

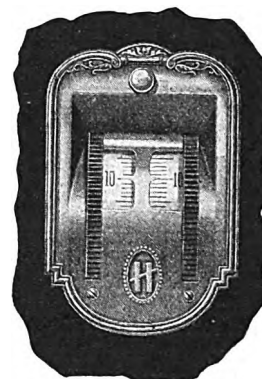
Write for Folder
HAMMARLUND MFG. CO.
424-438 W. 33rd St., New York

**For Better Radio
Hammarlund
PRECISION
PRODUCTS**

Above is shown how accurate alignment of Hammarlund Condenser plates is assured—firmly anchored in a metal holder, each plate in its own slot, while the tie-bars and solder are applied.

Laurence Cockaday's "LC-28" RECEIVER, The VICTOREEN and The New HAMMARLUND -ROBERTS "Hi-Q"

are among the score
or more new receivers
using HAMMARLUND
PRECISION PRODUCTS



**Illuminated
DRUM DIAL**

Beautifully designed and substantially built. Gives distinction to any receiver and greatly simplifies tuning. Two finger control. Illuminated from back of panel.



Greater Values are Shown in our New Big 1928 Dealers' Catalog

New Kits featured include: Aero-Bodine—Camfield—Citizens—H-F-L—Infradyne—Kara—Melo—Heald—Scott's—Silver—Marshall—St. James—Tyman—etc.

EVERYTHING new and desired—all under one roof. You don't need to look elsewhere. Complete stock carried. Prompt, efficient, dependable service.

Write for your copy today.
See what you SAVE.

Established 1918



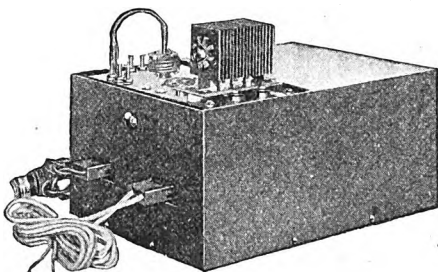
TELEPHONE MAINTENANCE CO.
123 South Wells Street Dept. 68 Chicago, Illinois

CHICAGO'S OLDEST RADIO HOUSE



WHOLESALE ONLY

electrify your set the easy practical Knapp way....



The Kit completely assembled with metal cover in place. Operates on 105-120 volts AC, 50 to 60 cycles.

Knapp "A" POWER KIT

No expensive short lived AC Tubes, no troublesome re-wiring, no annoying hum. Increase instead of decrease the efficiency of your set, no waiting... the Knapp "A" Power gives you music *instantly* at the snap of a switch.

This absolutely dry "A" Power is not in any way a battery combination... not something to add to your battery... it is the most efficient "A" Battery Eliminator ever designed. It supplies unfailing "A" current to any set using 201-A or 6 volt tubes, regardless of number.

Magic Silence

So silent is Knapp "A" Power, that you can place a pair of head phones directly across the output and not be able to detect a hum. This is made possible by the efficient Knapp filter system, consisting of 2 over sized chokes and 2 condensers of 1500 microfarads each. A new discovery makes these amazing capacities possible in the small space of 2x2x8 inches!

Absolutely Dry

There is not a drop of moisture in this absolutely dry unit. The condensers are baked so that not a drop of moisture remains. The unique, fully patented, solid, full-wave rectifier is absolutely dry. No water... no acid... no alkali... no tubes... no electrolytic action. Nothing to get out of order. Nothing that needs attention.

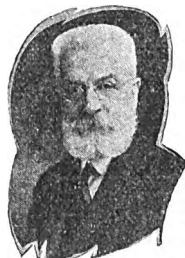
Assemble in Half an Hour

The Knapp "A" Power Kit is so easily assembled, that within half an hour after you receive it, you can have it in operation. The parts seem to fall in place. No drilling and very little soldering. Everything supplied, even to the screws, wire, drilled base-board and metal cover. It is so complete, that even a plug is supplied so that a "B" Eliminator may be operated from the same switch. We have never seen such simple instructions.

Big Profits for Set Builders

Our president, Mr. David W. Knapp, is offering the set builders of America, for a limited time only, a money-saving, profit-making plan which is unique in the annals of radio. Send the coupon today, before it is too late.

Knapp Electric Corporation
Port Chester, N. Y.



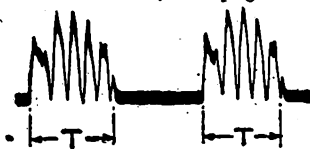
MR. DAVID W. KNAPP, Pres.
Knapp Electric Corporation
301 Fox Island Road,
Port Chester, N. Y.

Send me complete information regarding the Knapp "A" Power Kit and your special discount to Set Builders.

Name.....
Address.....

The Earth's "Radio Roof"

(Continued from page 113)



HOW REFLECTED WAVES CREATE DISTORTION

FIGURE 6: Above is the type of signal received when a steady signal (but not of constant frequency) was transmitted in the experiments, showing the distortion resulting at times when a reflected path occurred. The transmitted power was steady during the times marked T.

rise of six miles per minute and a fall of twenty-five miles per minute were observed. This rapid movement of the refracting region at night appears to be the cause of rapid fading of those wavelengths which travel well at night. If the reflecting or refracting layer were fixed and the frequency of the transmitting station fixed also, fading would not occur, but because the refracting region is moving fading is produced.

Another effect is bad quality of received signals under certain conditions, as has been proved by Bown, Martin and Potter.* When the reflected wave as received is of the same order of magnitude as the wave which comes along the ground, and when the frequency of the transmitting station is not constant, the signals arriving at any receiving station over two paths will actually be of different frequencies. Traveling over different paths, two or more waves arriving simultaneously will have left the transmitting station at different times, and if the carrier-frequency of the station is not constant the waves will be of different frequencies. If the two waves are of the same order of magnitude, a beat note will result. For the large number of frequencies in a modulated wave, the correspondingly large number of beat notes results in noise which overshadows the speech or music being received. Experimental demonstration of this phenomenon is shown in Figure 6. Power of constant amplitude, but of varying frequency, was radiated from the transmitting station during the transmitting intervals; at the receiving station, the beats between the waves arriving over the two paths produced the distortion shown. For this reason constant frequency is essential in broadcasting.

* I. R. E. Proceedings, February, 1926.

NATIONAL TONE FILTER



The NATIONAL Tone Filter is made to be connected without tools, between your Radio Set and loud-speaker. Recommended by R. C. A. and other Power Tube manufacturers. It prevents burning out of speaker windings and improves tone quality. Complete with 3-ft. 'phone cord in fine black finish case . . . \$7.00

NATIONAL COMPANY, Inc., W. A. READY, Pres.,
MALDEN, MASS. Write for Bulletin 121

NATIONAL RADIO PRODUCTS

The Braid Slides back CORWICO BRAIDITE HOOK-UP WIRE

Simply push back the insulation on Braidite, make your connection, solder it, and the insulation slides right back into place, leaving no exposed sections of bare wire. Braidite holds its shape permanently after bending, and you cannot scorch or burn it with a soldering iron. Braidite is the easiest and fastest working hook-up wire made, yet it costs less than ordinary hook-up wires.

If your dealer cannot supply you write us.
25 Ft. Stranded Braidite.....35c
25 Ft. Solid Braidite.....30c
Made in red, green, yellow, brown and black.

CORNISH WIRE CO.
30 Church St., New York



Because of its superiority, Braidite is specified in all the leading popular circuits of the day. Use it in the next set you build.

An Unusual Radio "Dead Spot"

DURING the winter battle-fleet maneuvers of 1915-1916 of the United States Atlantic Fleet, I was attached to the *U. S. S. Delaware*, a super-dreadnaught, as radio operator. During the course of the exercises, I came across one of the most unusually effective radio "dead spots" (i.e., an area in which radio communication is virtually impossible of accomplishment) I have ever encountered.

We were engaged in maneuvers in the Caribbean Sea off the coast of Cuba, and while this area of the world is more or less notorious for "dead spots" the one mentioned below is the winner when it comes to stopping communication. On this occasion the *Delaware* was operating in Guacanayabo Bay, about 150 miles (air line distance) from the Naval Base Radio Station at Guantanamo Bay, when I had a message to deliver to the latter station.

I "opened up" on about one and a half kilowatts power with the quenched gap spark transmitter and called the station—without results. This procedure was carried out at the correctly specified intervals. I gradually increased my power to full strength with forty amperes in the antenna—and still no answer could I hear! In an interval of listening I heard what I knew to be one of our destroyers calling me from a position that was nearby but to seaward and outside the point defining the entrance to the bay. The operator said he was in easy communication with the station at Guantanamo and would relay my message for me. This suited me fine, so I gave it to him on reduced power and then he gave Guantanamo a single call on the same strength of power he used in calling me. Evidently he got him on the first trial, for he relayed my message at once!

Yet I, with my forty amperes in the antenna, could not get the base after almost an hour's work! This was some dead spot, I concluded. After going off watch I went up to the chart house and looked up the geographical aspects of the situation. Ultimately I reached the conclusion that the innocent looking mountain range (The Sierra Maestra Mts.) extending between the point where I was located at Guacanayabo Bay to the base at Guantanamo Bay, was probably responsible for the difficulty. I further ascertained that there was known to be a considerable body of iron ore in the portion of the range adjacent to Guacanayabo Bay, and this doubtless was definitely responsible for the failure of the radio signals to get through from my station, while the comparatively low-powered transmitter of the relaying destroyer got the message through perfectly.

—LIEUTENANT H. F. BRECKEL.

Complete Kit of Parts for the New **HARKNESS** **Counterfonic Six** —the set with *tuned audio amplification*—

WITH this complete kit of parts you can build—in less than three hours—the new HARKNESS Counterfonic Six described in the December and January issues of POPULAR RADIO.

Using the new "tuned double impedance" system of audio amplification the Counterfonic reproduces music and the human voice with amazing realism. Never before has it been possible to re-create musical sounds with such remarkable fidelity.

Other new and exclusive features are:—a new method of shielding; a new system of neutralization; single-dial tuning made 100% efficient. Distant stations night after night. Perfect selectivity.

The complete kit contains everything for building the set exactly as specified by Kenneth Harkness. Assembly and wiring fully explained in the instruction folder.

If your local radio dealer does not stock the HARKNESS Counterfonic Kit mail your order to the address below and the kit will be sent you at once. If you do not want to build the set, write us and we will arrange to have it built for you.

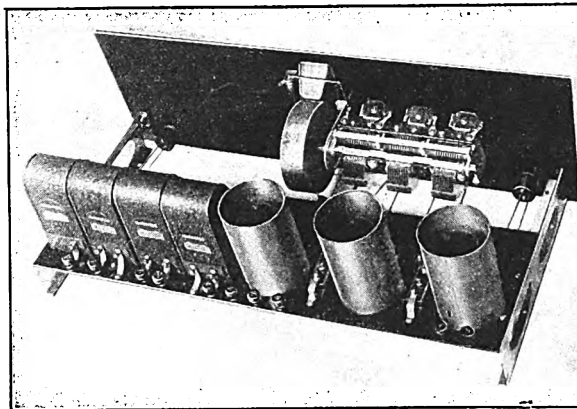


Complete Kit List Price

--all parts **\$68.50**
to build set

**BIG Discounts
to Dealers!
and Agents!**

You can make money building Harkness Counterfonic Receivers. As our authorized agent you can buy the complete kit of parts at a big discount and make a large profit on the sale of the finished set and accessories. Write today for our agency proposition and wholesale price list of complete line.



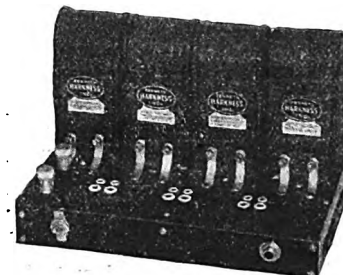
HARKNESS *Tuned Audio Amplifiers*

THE HARKNESS Tuned Double Impedance Audio Amplifier is a separate, completely wired unit which can be attached to any radio set in a few moments, without tools, and without making any changes in the set. It can be used with any radio receiver, from a crystal set to a super-heterodyne. Supplied complete with battery cable and "Input" connecting wire. Complete instructions given. Anybody can attach it.

The HARKNESS Amplifier greatly improves volume and tone fidelity. It is tuned to emphasize low tones and offsets the "falling characteristic" of loudspeakers at low frequencies. It can handle four times as much volume as any other type without overloading, tube blocking or distortion of any kind.

The HARKNESS Amplifier is made in two types, as described on the right. Type A-400, with push-pull output, is recommended for the LC-28. If your dealer cannot supply you mail your order direct.

Dealers and Set-Builders. We allow liberal discounts. Write for wholesale price list of complete line.



LIST \$35.00
Type A-300. 3-tube Amplifier with 3 stages tuned double impedance amplification and speaker filter.

LIST \$45.00
Type A-400. 4-tube Amplifier with 2 stages tuned double impedance amplification and one stage double impedance push-pull amplification.

KENNETH HARKNESS, Inc.

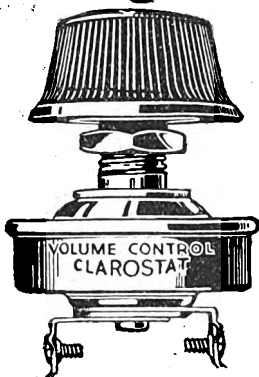
Suite 605-C, 72 Cortlandt Street, New York, N. Y.

Whether it's battery or A-C Tubes— BE MASTER of your set

RADIO can be a pleasure or a curse, depending upon whether you run your radio set or your radio set runs you. An uncontrolled radio set is like an automobile without steering wheel and throttle—except that the latter soon kills outright, whereas the former causes a slow, lingering, painful death to the owner and others.

YET nothing is simpler than the control of your set, whether equipped with A-C or battery tubes. In the case of either type of tubes, just connect a

VOLUME CONTROL CLAROSTAT



across antenna and ground binding posts of your set. Now you have distortionless control that gives you anything from full output to mere whisper—from dance music for shuffling feet to soft background for dinner conversation. All for \$1.50, and instantly applicable to any receiver.

Again, you must control power supply for A-C as well as battery type tubes. In the case of A-C tubes, you must compensate for line voltage fluctuations. This is essential for best results. Much of the hum with A-C tubes is due to improper operating voltage.



In the case of all B-power supply devices, you must also compensate for line voltage changes. The solution here is a Power Clarostat (25-500 ohm range) connected in primary circuit of power transformer. You can instantly adjust A-C tube filaments or heaters, B and C voltages, all at one time. Applicable to any set or radio power unit. And all for \$3.50.

Write us for data on how to improve your radio, whether A-C or battery operated. **And when you buy CLAROSTATS, be sure you get the genuine, distinguished by familiar green box and name Clarostat stamped on nickelled shell. Accept no substitutes!**

AMERICAN MECHANICAL LABS., Inc.



**Specialists in
VARIABLE RESISTORS**

**285 NORTH 6TH ST.
BROOKLYN, N. Y.**



Pacific & Atlantic

HOW IT'S DONE IN RUSSIA

These two radio fans, who appear to be as ardent as the American variety, are Russian peasants, listening in on the latest broadcast from Moscow. Note the Russian radio magazine that one of them holds.

BROADCAST LISTENER

*Comments on radio programs, methods and technique
—from the point of view of the average fan*

By **RAYMOND FRANCIS YATES**

Memory Songs

HERE we are running into November with the sob song supply at the highest point in the history of the industry. It's strange how these sublime emotional assaults on the national heartstrings continue to be popular. Studio managers seeking sure-fire stuff never overlook the bet of a good old-fashioned quartette wailing sentimental ballads full of tender nothingness and ten-cent-store romanticism. In the whole range of vocal material nothing is more effective. In the great American home, it would seem, than these mushy tear-wringers; and our broadcasters, always alert to the cravings of the morons of music, dish out the choicest morsels of doleful hash.

We are at present busily engaged in incorporating a new organization which we hope will, in some measure, stem the tide. We have called this organization the Society for the Conservation of Tears, and those in sympathy with the idea we ask to write a letter of protest to each broadcaster in the United States requesting the discontinuance of the twilight series.

* *

All Aboard

ALONG with the sob songs we have also suffered through a severe season of "musical tours"; a musical tour being an hour or so of the music of foreign lands, filled with colorful descrip-

tions by announcers who have never visited them. Cook's tours at WJZ started this musical tour business several years ago and they have done splendidly at it—so well, in fact, that the studio Johnnies have ragged the idea until it is now one of the many common properties of broadcasting. Broadcasting is so hungry for new ideas that it devours a novel idea with an avidity that would be admirable were it not so monotonous.

If we have listened to one musical tour during the season, we have listened to a hundred of them, and we are all fagged out after having "covered" millions and millions of miles and having passed some of the most glittering announcer landscapes ever painted.

Musical travelogues were once quite novel and entertaining, but we fear that we shall have to put our radio baggage away for a few months at least. Already we have made 187 trips to France, 149 trips to Italy, and 97 trips to Russia. Little wonder that we are all tucked out and that we crave a few quiet evenings at the fireside listening to the sopranos and baritones that used to annoy us so much. After all, a radio soprano or a tenor is not so bad for a change. Perhaps we might suggest the formation of a "Stay-at-Home-and-Listen-to-the-Sopranos League." This is the last thing we would have thought of a year or so ago, but times have a habit of changing, you know.

The Individual Tube

Z O

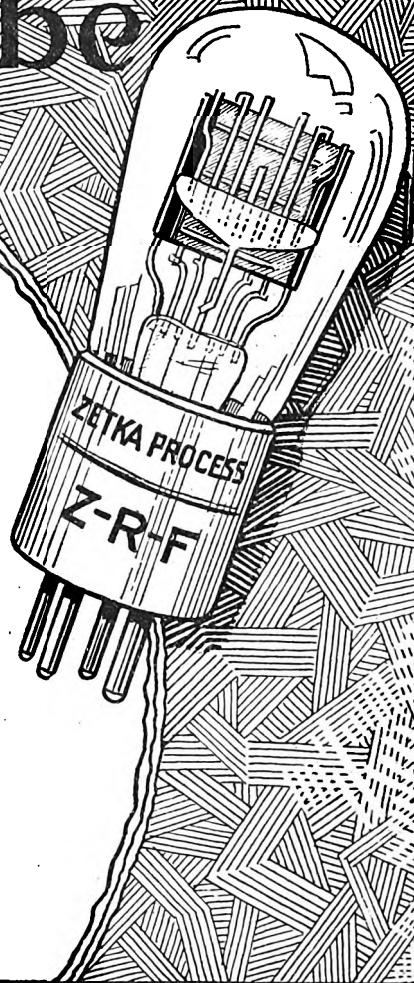
ANOTHER INDIVIDUAL TUBE

A Fit Companion to the New Line of
Zetka Process Special Duty Tubes

A new output tube, developed in our laboratory, to handle the output volume of modern 6 to 10 tube receivers without overloading.

The new ZO tube is a 5-volt, $\frac{1}{2}$ -ampere tube, operating at 180 volts plate with 35 to 40 volts negative grid bias, and is designed to handle the tremendous volume delivered by a full set of Zetka Process Special Duty tubes without distortion.

For push-pull amplification, the ZO, used in both the input and output stages of a push-pull amplifier, will produce an enormous volume with almost unbelievable depth and clarity of tone. Write for details.



**ZETKA tubes are GUARANTEED
to give satisfaction**

ZETKA LABORATORIES, Inc.

67-73 WINTHROP ST.
NEWARK, N. J.

ZETKA

CLEAR GLASS TUBES

Z-R-F—Radio Frequency Amplifier, 5 volts, $\frac{1}{4}$ amp. High amplification constant. Low plate impedance, and low internal capacity. Uses 90 volts on plate... Price \$4.50

Z-D—Super-sensitive Detector. 5 volts, $\frac{1}{4}$ amp. High amplification constant. Silent (no hiss). Uses 45 volts on plate..... Price \$4.00

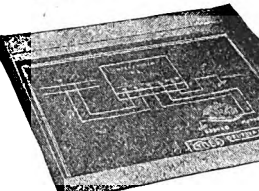
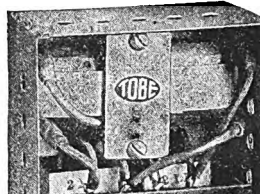
Z-A-F—Audio Frequency Amplifier. 5 volts, $\frac{1}{4}$ amp. Higher μ , low impedance. Plate voltage 90 to 135 Price \$4.50

Z-A-O—Audio Output, or Power Amplifier. 5 volts, $\frac{1}{2}$ amp. For handling large output volume without distortion. Plate voltage 180, with 22 $\frac{1}{2}$ volts 'C'..... Price \$4.50

RADIO INTERFERENCE FILTERS

conformance with code regulated metal box, for attachment to machinery.

Wrought out to a Bakelite strip cast, and openings are left, of proper size for attachment.



Interference Filter No. 2

Interference Filter No. 2

TOBE DEUTSCHMANN CO., *Cambridge, Massachusetts*

City.....State.....

But this should not be taken as a sweeping commentary to the effect that all of our announcers are incapable of doing anything but reeling off sun-baked proclamations between numbers. Such an indictment would be eminently un-

fair to some very capable men (yes, and about two ladies) who handle themselves with admirable skill before the microphone. On the other hand, the most liberal supporter of broadcasting must agree that the rank of at least 50 per cent of our announcers should be reduced to that of mere call boys giving unimaginative accounts of program happenings. Of course, we cannot expect all our broadcasters to be able to afford the kind of talent necessary to create pleasant impressions in the minds of the more sensitive listeners.

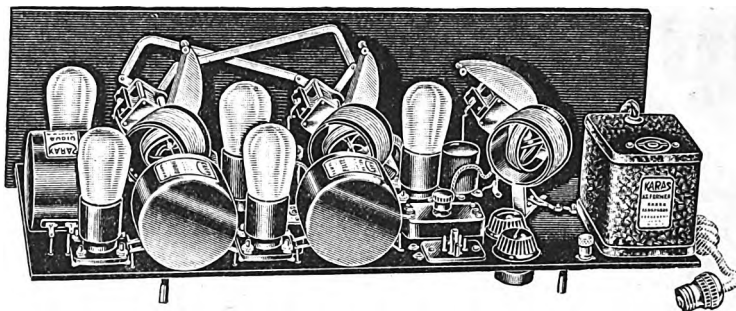
The first essential in announcing is that the announcer shall be a man sufficiently versed in rhetoric and polite, scholarly expression to be able to forgo his training.

As soon as he becomes conscious of an effort to interest his audience by the adroitness, subtlety and witticism that mark men of fair letters, he becomes a mere pretender with no more claim to sympathy and approval than a mere pretender should have. Good manners, be it known, cease to be good manners when the effort to push them into the foreground is painfully present. An announcer must be so sure of his ground that his politeness will be an invisible but intrinsic part of his make-up.

It is plain that an announcer, to meet the ideal of something akin to true art, may not be the announcer that would best please the lower classes, who still get a kick out of rowdyism, slapstick comedy and literary pie throwing. But we cannot afford to permit this class of people to set up our ideals in broadcasting. At least there is no possibility of a cultured announcer shocking the finer sensibilities of those who purchase radios for the sole purpose of drinking in nothing but the belligerent cacophonies of the more rancorous vendors of this so-called American Folk Music. An announcer, under these conditions, might be tolerated but never acclaimed.

Announcing is far from a mastered art, but in the same breath we must fight against the notion that one man's opinion is as good as another's, or that it is impossible to concoct a formula that will serve the largest number of listeners in the best way. Such a formula must hold that successful announcing lies somewhere between icy formality and unmitigated prattle. *Otium cum dignitate* ("ease with dignity") seems to come pretty close to a code in itself.

It certainly is not right to admire many of our announcers for the studious manner in which they not only absorb but recite the contents of musical dictionaries and encyclopedias. This may permit them to turn a burnished surface microphone-wise, but in such cases they appear too conspicuously informed. Perhaps the writer would be a bit unkind to say that too many of our announcers are affectations or that they are to be classed with pretenders. Still, not one



THE KARAS A-C-EQUAMATIC is a set you will enjoy building

YOU will get a tremendous "kick" out of building the Karas A-C-Equomatic. You will find that in a few hours you can assemble a REAL A. C. 5-tube receiver that delivers more real radio entertainment than any other receiver you could possibly build or buy. That's because the Karas A-C-Equomatic utilizes the famous Equamatic principle of tuning, is completely neutralized and perfectly balanced, and IT IS A REAL A. C. JOB, not a makeshift A. C. set.

Complete Instructions Are Easy to Follow

Our complete blue prints and full size details enable you or anyone, even without experience, to build the Karas A-C-Equomatic in a short time. Every wire is plainly indicated, every hole correctly placed. Every part will fit perfectly. You will be amazed how easily and quickly you can build this wonderful set.

The Karas A-C-Equomatic eliminates the need for all "A" batteries, chargers, relays, etc. It uses the new A. C. tubes in conjunction with the marvelous new Karas A-C-Former Filament Supply which is built right into the set. As a result this receiver has a purity of tone, a volume and a selectivity that are astounding, and its distance-getting powers are phenomenal.

Uses the New Karas A-C-Former

The new Karas A-C-Former used as a source of filament potential in the Karas A-C-Equomatic is a finely built piece of apparatus that delivers an absolutely correct voltage to each tube, WITHOUT VARIATIONS, and free from fluctuations, surges or other damaging A. C. impulses that play havoc with the new A. C. tubes unless an A-C-Former is used. No hum—no overheating—just 100% perfect A. C. operation, free from all battery troubles, and with your set always at tip-top efficiency because of correct filament voltage.

Build this great receiver! Enjoy its tremendous pep, punch and power—its crystal-clear reception and its remarkable selectivity. Send today for complete set of FREE wiring diagrams, full details and all data you will need to build the A-C-Equomatic. ACT NOW. Mail the coupon today.



KARAS ELECTRIC CO.
4029-B No. Rockwell Street
CHICAGO

Fill Out and Mail Coupon Today

The coupon at right brings everything in the way of details you will need in order to build the Karas A-C-Equomatic. Your dealer can supply you with the necessary Karas and other parts. Fill out and mail coupon NOW. See your dealer about the parts for your set.

KARAS ELECTRIC CO.
4029-B No. Rockwell St., Chicago.

Send me complete details, wiring diagrams, etc., for the Karas 2-Dial A-C-Equomatic 5-Tube Receiver as advertised in Popular Radio for February, and also testimonials of results gotten with this set.

Name.....

Address.....

City.....State.....

POPULAR RADIO DEALER AND JOBBER LISTS AVAILABLE TO MANUFACTURERS

The Service Bureau of POPULAR RADIO is able to place at the disposal of radio manufacturers a list of over 21,000 radio dealers, 3,926 radio manufacturers, 1,746 jobbers and 326 manufacturers' representatives. These addresses are immediately available for circularizing prospects for new 1928 lines, and more detailed information and rates will be gladly supplied to those who wish to take advantage of what is without doubt one of the most carefully kept lists at present offered for use.

Address all inquiries to:

SERVICE BUREAU

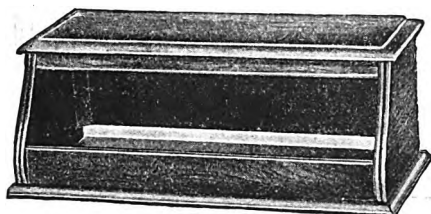
POPULAR RADIO, Inc.

119 West 57th Street

New York, N. Y.

CORBETT CABINETS

FOR THE LC-28

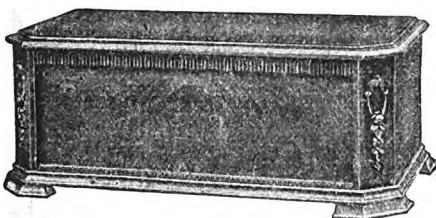


Model LC-28 Walnut \$18.00



Model LC-28-D-20 Walnut \$70.00

The authorized cabinets for the LC-28. Made to take the aluminum 6x26-inch panel, with 25 degree slope.



Model "C" Walnut

The ultimate in elaborate and attractive radio cabinets is offered in our model "C." It is an adaptation of the old Italian Chests, being designed and decorated after the spirit of the Renaissance period.

Grooved for 3/16-inch panel with removable top rail. Fancy top stay and piano hinge are applied.

PRICE LIST

MODEL "C" CABINETS

Walnut Only

Panel Size	10 in. deep	12 in. deep	Weight	Mounting Boards
7x18	15.50	17.00	26	.90
7x21	17.00	18.50	28	1.00
7x24	19.00	20.50	31	1.10
7x26	20.50	22.00	34	1.20
7x28		23.00	37	1.30
7x30		24.00	40	1.40

Corbett cabinets are in stock ready for shipment.

Write for illustrated folders.

CORBETT CABINET MFG. CO.
ST. MARYS, PENNA.

announcer has been heard making these "high-brow" announcements who could not be accused of soliloquizing.

An announcer, to approach an ideal, must permit his true natural self to reign.

It is edifying to note that the announcers who do this are those who are most graciously received by the public. Roxy (S. L. Rothafel) at the Roxy Theater, New York City, is a perfect example of the unaffected announcer. His appalling popularity, extending all the way from the White House to New York's East Side, is more than a fair index to the correctness of this theory. A man who cannot melt into a genial human being before the microphone should not be permitted to approach it.

Voice quality, although it has been little emphasized by the majority of our studio managers, is of first importance in announcing.

Few items are more obnoxious in radio than a voice that only mildly suggests the masculine gender. Such voices are usually associated with sentimental, flowery expression that can do little but disgust the more practical and virile members of the radio audience.

There is a technical similarity between the photographic requirements of the movies and the acoustic requirements of broadcasting, although the latter has not as yet become a generally recognized fact. In the early days of the movies, any "actor" who could throw a pie with fair aim was star material, regardless of the manner in which he photographed. Nowadays women with tantalizing beauty are turned away from the studios because the camera, for some reason or other, does not treat them with the greatest respect. The microphone, too, is a gay deceiver and a perfectly modulated voice of pleasing quality may be cruelly distorted; it simply refuses to "microphone" well.

The chronic devotees of the radio, those who take more than a passing interest in the trials and troubles of the baby art, have probably given painstaking attention to the matter of voice transmission and they know, better than many of our studio managers, the tragedy of poor voices that have to be listened to day in and day out. Some day, perhaps, we shall have some sort of a voice analyzer, similar to Dr. Miller's remarkable phonodiek. A visible record can then be produced that will form a scientific basis for voice success on the air.

WEAF's management has demonstrated a remarkable aptitude in the selection of amazingly perfect radio voices. The critical listener cannot help but notice the similarity in register, which shows that more than passing notice has been given to the matter of uniformity and that the selection of announcers has been based largely on scientific auditory tests.

One trouble with many of our studios is that they expect an announcer to be a master of a situation that is hopelessly beyond the mastery of a single man. Take, for instance, an announcer who is called upon to officiate through the entire program of a well-nourished New York broadcaster. The evening holds many adventures for a man whose scope of learning does not take in a vast and widely diversified range of subjects. He may be called upon to comment intelligently in connection with such widely separated things as Tchaikovsky's "Symphonie Pathétique," or a lecture on the migratory habits of birds.

It has always seemed to the writer that smoother studio operation would result from the employment of two types of announcers, one with more than superficial knowledge of music and the other a well-rounded-out man of experience and worldly knowledge. As much of the matter broadcast is musical in nature, it is essential that we have an announcer who can supply the explanatory sketches and pronounce the many foreign names with comfort and authority. It usually happens that a man sufficiently grounded in music is lacking in other requirements, making him unsuited for use in general announcing. On the other hand, the man best suited to general introductions is usually distressingly ignorant of music.

The logic of this special announcer theory is given pretty substantial support by no less a person than J. Andrew White, *bel esprit* of sport assignments for the radio. While White is no doubt an amateur sport observer, his reflections are the more entertaining and edifying because of this. His accounts are accurate, yet he does not go to any great pains in drawing gorgeous pictures with lavender scented phrases. This writer has always preferred to look upon White as the "rough rider of the air," the Teddy Roosevelt of the announcing business. His descriptions are double-distilled of bunk and one may always listen to them in confidence and comfort.

It is, or should be, left to the announcer to establish an intimacy between the listener and the studio. He should be able, in a measure, to overcome the limitations of radio transmission and bring to the listeners a fair impression of what is actually taking place in the studio. For instance, a few words about the grouping of an orchestra before the microphone or the back-stage scenery of a Carnegie Hall concert not only help the radioist to visualize better the thing and draw him closer to the whole event, but they help him to become more intimate with the station itself, establishing a sort of invisible bond of understanding.

It is an easy matter for a sanguine, observing announcer to add these little touches that mean so much to fans.

CARBORUNDUM

GRID LEAKS

RESISTORS

for
NOISELESS
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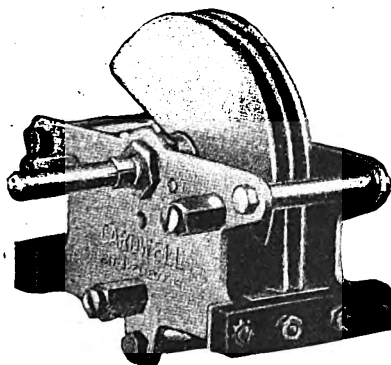
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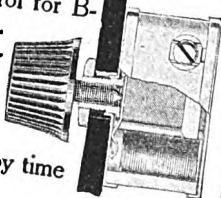
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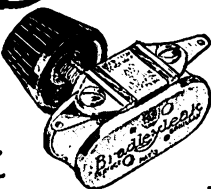
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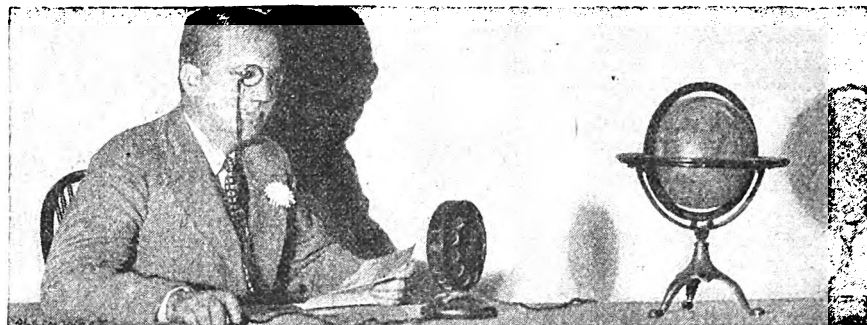
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BROADCASTS

A Year's Progress in Radio Direction Finding

PROGRESS in the new art of navigation by the use of radio beacons and the radio compass made great strides in 1927, according to Dr. F. A. Kolster, research engineer formerly with the U. S. Bureau of Standards, and inventor of the Kolster radio compass. The 30 radio beacon stations that were in existence in this country a year ago have been increased to 45, and 12 more are in the process of construction. Together with the beacons established on the Canadian coast, the North American continent now has a fairly complete chain of stations from the Gulf of Mexico to Alaska, and along the Great Lakes. The leadership of the United States in this field is indicated by the fact that the total number of beacons in the world at present is 81, of which 45 are in this country.

The progress in the installation of radio compasses in ships has kept pace with the growth in number of beacon stations. In addition to a large num-

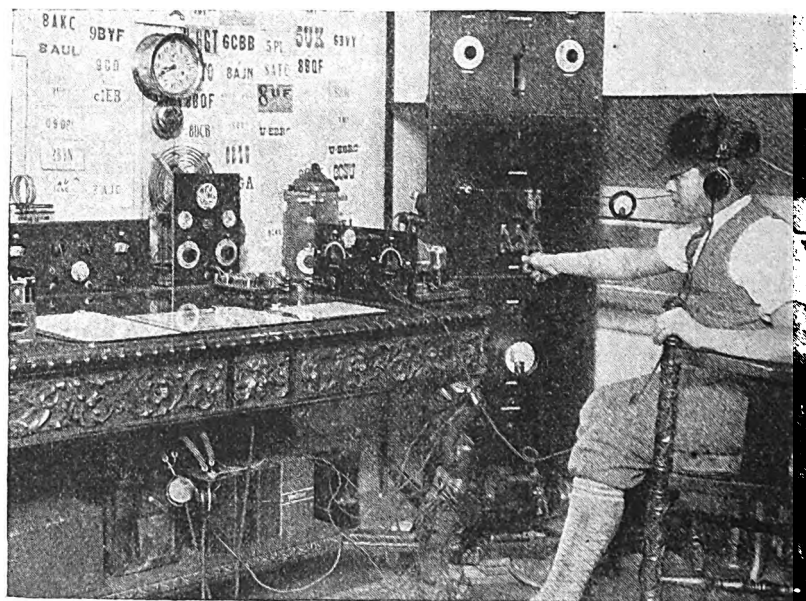
ber of naval vessels, it is estimated that more than a thousand commercial craft are now equipped with radio compasses for getting their bearings by radio. About 600 of these ships are American.

The most phenomenal progress in this field has been shown on the Great Lakes, where two years ago there was not a single radio beacon. Now there are 19, and a large proportion of the important shipping on the Lakes is done with the aid of radio compasses, this method being almost indispensable in fogs and storms.

* *

A New Record in Broadcast Hook-ups

A THOUSAND dollars a minute was the price paid recently by the Dodge Motor Company for an hour's broadcast, which employed three transcontinental circuits totalling twenty thousand miles and a telegraphic communication circuit of ten thousand miles. It is estimated that thirty million people listened in on the program, which was participated in by Will Rogers, Fred



Underwood & Underwood

THE YOUNGEST "HAM"

The youngest licensed radio operator in the country is Robert Marx, shown above with his 40-meter transmitting set. His call letters, 2AZK, have been heard in nearly every part of the world, and he is said to work with 12 foreign stations regularly every night. He is thirteen years old.

and Dorothy Stone, Paul Whiteman and Al Jolson, each in a different corner of the country. The hook-up was both the greatest mechanical achievement in radio telephony and the costliest program ever given.

* *

Tonsils and the Radio Needle

At a recent medical demonstration before the Philadelphia Laryngological Society in Atlantic City, a needle excited with a high-frequency current of the order of 2,000,000 cycles (150 meters) was used for the bloodless removal of tonsils. At a touch of the needle, the diseased areas of the tonsils turned white within less than three seconds. Dr. Coulter Charlton, who made the demonstration, declared that the operation was absolutely painless and bloodless, the blood vessels being sealed up within the sound tissue. Patients showing tonsils in various stages of the drying-up process that results from the application of the needle were shown to the gathering. Dr. Charlton said that the use of the needle would be especially valuable in cases where the use of a general anaesthetic might involve great risk, or where a hemorrhage might have serious results. Physicians were also inclined to believe that the needle might prove valuable in the treatment of cancer.

* *

Radio Photography Captures a Criminal Abroad

With the help of radio photography, the long arm of the law reached across the Atlantic recently to capture a criminal in London who was wanted in Chicago. An exchange of fingerprints between Scotland Yard and Chicago, by means of radio, identified the fugitive, and the British authorities returned him to America to stand trial.

Transoceanic Calls Heard

THE amateur station of Maurice Goud (EF-8KV), Vernon (Eure), France, reports the reception of the following stations in the United States, using a Schnell circuit with detector and one stage of low frequency:

1BUX, 1BYV, 1UW, 2AQW, 2BAA, 8ADG.

CESAIRE GRANGIER, operator of amateur station FM-8MA, Casablanca, Morocco, reports the reception of the following stations in the United States, using a detector and one stage of low frequency:

1BHM, 1LP, 1RF, 2AGN, 3CUQ, 2GK, 3SJ, 5JF, 5KC, 8BUN, 8KF.

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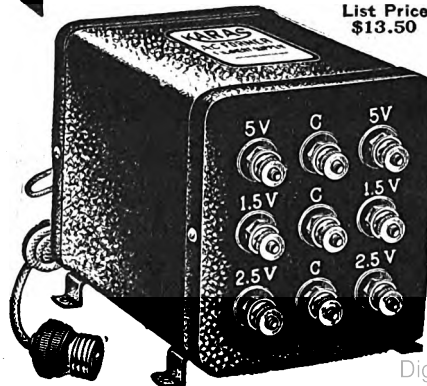
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Popular Radio

EDITED by RAYMOND FRANCIS YATES



FOUNDED 1911

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March, 1928

NUMBER 3

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LAURENCE M. COCKADAY, Technical Editor

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CHARLES L. DAVIS, Managing Editor

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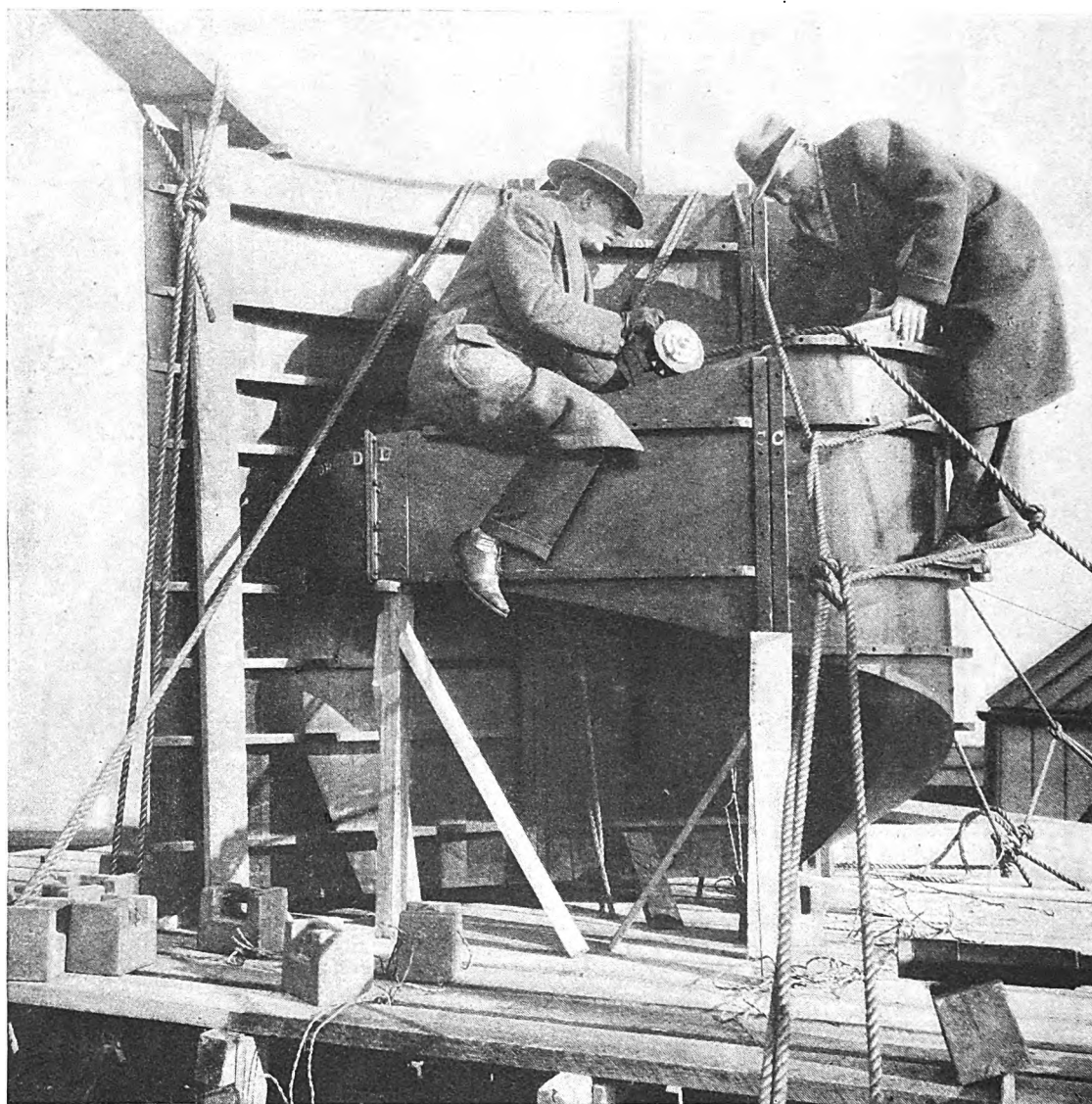
I have been a staunch follower of the editorial contents of POPULAR RADIO for many years and feel that you have contributed much toward the development of the radio industry. POPULAR RADIO has always been alert to new trends and new developments, and has pioneered with those advancements that are really worth while. Your laboratory and technical department has been very helpful to me and, I am sure, to many other serious-minded radio enthusiasts.

Leslie G. Biles.

SECRETARY,
HAMMARLUND-ROBERTS, INC.

LESLIE G. BILES

Leslie G. Biles started his career as an amateur in 1909. Then, after considerable laboratory experience, he became Technical Radio Editor of the Philadelphia *Public Ledger*. In this connection, Mr. Biles had an opportunity to do a great deal of research and experimental work. He then became Managing Editor of *Radio-in-the-Home*. He left this position to become Secretary of Hammarlund-Roberts, Inc. He has written for all the leading radio magazines and newspapers, through which he has established a reputation as an outstanding authority on many phases of radio.



Bell Telephone Laboratories, Inc.

A Radio Voice That a Million Could Hear

The amazing development work that has taken place in reproduction during the last two years is well typified by this giant speaker which proved capable of hurling a man's voice across the Hudson River at its widest point. Several years ago voice projection was measured in feet. Now, with the aid of this new Hercules of horns, which weighs several tons, the human voice can be flung over a mile. The horn is of the exponential type and is provided with a group of nine reproducers attached to its small end. Each reproducer is provided with a moving diaphragm of aluminum alloy, measuring only .0002 inch thick, and attached to this diaphragm is a small coil of aluminum strip insulated with varnish. The voice-modulated currents pass through this aluminum strip and, interacting with a powerful magnetic field, cause the diaphragm to respond in perfect sympathy with the voice current. A new record of efficiency has been established with this equipment. Frequencies as low as 60 and as high as 6,000 cycles are reproduced with amazing efficiency of 50 per cent. This means that 50 per cent. of the electric energy supplied to the horn is converted into sound. The horn and its accessory equipment has been developed by the engineers of the Bell Telephone Laboratories, Inc.

Popular Radio



VOLUME XIII

March, 1928

NUMBER 3

Does Static Come Up From the Ground?

Since the inception of radio communication, engineers have accepted the theory that static interference is a phenomenon associated with the atmosphere and that the visitations of static impulses is the direct result of exposing parts of our receiving apparatus to the air. It has been insistently imagined that these rebellious gushes of static strike our aerials and rush pell mell through our receivers to the ground. How shocking it would be if we had to revise this conventional notion and picture static as a ground phenomenon, with terra firma as its abode in place of the sky. Such is the astounding theory of Dr. Richard Hamer, whose brilliant researches outlined in this article have supplied what would seem to be sound verification for this amazing conclusion.

By DR. RICHARD HAMER

Department of Physics, University of Pittsburg

STATIC, radio's arch enemy and all-pervading nuisance, has to date successfully eluded the efforts of our best engineers. It is still as rampant and capricious as it was when it surged through Signor Marconi's little coherers back in the infantile days of the art.

Although the presence of static is the most obvious thing imaginable, it is surprising how little is actually known about its ultimate nature and the source of its generation. Since it first manifested itself, it has been held that it was a phenomenon of the air, and that it took up its permanent dwelling in the wide-open spaces between the aerials of the world. That this method of reasoning might, after all, turn out to be a fallacy is suggested by experiments which the writer has performed.

The theory is proposed here that fluctuations of atmospheric pressure and their consequent effect on the earth is one of the main causes of static, of earth currents, and of the variations in earth currents and in the magnetic field which the earth generates.

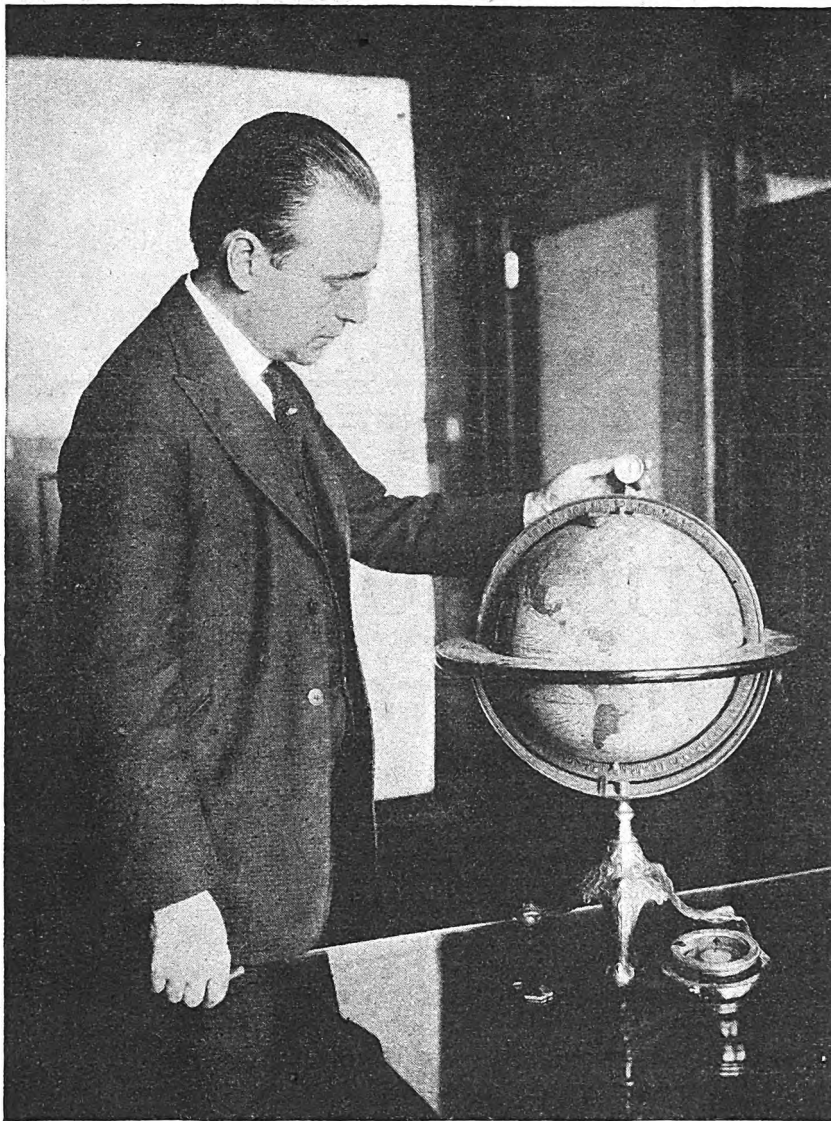
The ever-varying changes of atmospheric pressure due to meteorological conditions give rise to a varying potential of the grounding conductor with respect to the earth itself, or else actually cause a redistribution of electrons or ions in the regions near the locality where the pressure changes. They also seem to change the resistance of the earth considerably.

Experiments undertaken by the writer seem to indicate that all these factors possibly exist, and perhaps exert their own effects at the same time. In an experiment, a glass tube about one meter long was filled with moist earth. Two brass discs were inserted about ten centimeters from each end, with their brass rod connections insulated from the earth by glass tubes extending out through the rubber stoppers used to close the ends. These disc electrodes were connected in series with a sensitive galvanometer. Suitable tube connections were arranged at the top end so that the soil in the tube could be subjected somewhat suddenly

to a reduced or increased pressure by means of an aspirator or an air compressor. Figure 1 shows the set-up used.

Changes in air pressure caused noticeable variations in the current which was found to flow, due to the fact that polarizable electrodes were used. Similar variations were observed when a battery was put in series. This would indicate that the soil acids gave rise to an electric current owing to their chemical action on the brass electrodes and that variations in pressure caused variations in the local concentrations at the surfaces of the electrodes, and so made the currents vary. Another view is that the pressure changes modified the resistance of the earth just as the agitation of the telephone transmitter diaphragm varies the resistance of the carbon granules.

An attempt was next made to eliminate the polarization and resistivity effects which were undoubtedly present, by using a quadrant electrometer instead of a galvanometer and separating



DOES STATIC HIDE IN THE EARTH?

The phenomena of earth magnetism and static, which seem to be related, have been the subject of some of the most ingenious experiments of modern science. Dr. Hamer's researches go a long way toward clarifying the known facts of terrestrial magnetism, atmospheric disturbances and static.

the electrodes from the soil by glass. One end was earthed and the whole tube covered with tinfoil, which was also earthed. Figure 2 shows the second set-up. The same variations in pressure gave rise to deflections of the needle such as would be caused by a redistribution of electrical charges in the soil.

These latter experiments indicate that there is an actual redistribution of electrons or charged ions throughout the mass of earth when the air pressure is suddenly varied. It is quite possible that in the case of static and earth currents these factors (change of polarization, resistivity variation and ionic redistribution) are all present and exert an influence.

It is obvious that anything which

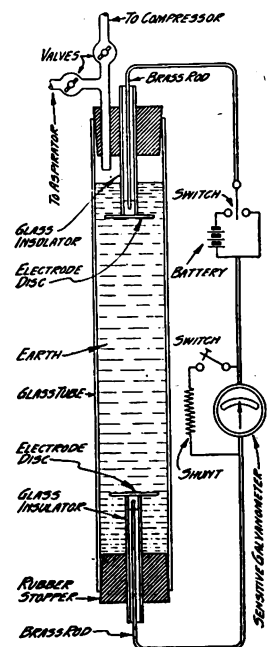
tends to change the contact potential of a grounding wire with respect to the earth, or which causes a redistribution of ions or electrons in the earth, temporary or otherwise, will play a definite part in the recording of any instrument using a grounded connection. It would also follow that static would perforce affect all wavelengths more or less indiscriminately. That such is the case seems to be indicated by wireless experiments.

From these results it would seem that static due to local meteorological conditions may be reduced considerably by burying the grounding wire very deeply with the connecting wire insulated from the moist earth, or by using an extensive spider or mat of conducting wires either above the ground and not in

actual contact with it, or else on or below the surface of the ground, but insulated from it. The spider device is generally used for transmission only and undoubtedly is a great improvement for the reason that local variations of the contact potential of the "ground" are considerably reduced.

All earth-current measurements obviously demand that the connections with the earth shall be stable and not liable to fluctuations, gradual or otherwise. The elimination or determination of these should be a first consideration before much reliance can be placed upon the apparent results. Non-polarizable electrodes should be used. These should help partially in the case of static.

It is difficult to suggest a means of reducing or overcoming the static or the fluctuations due to atmospheric pressure variations at a distant area. Perhaps inland points should endeavor to have good water connection; with as large a water area as possible, and so attempt to have complete water connection between transmitting and receiving stations. Experiments are planned to determine if pressure variations on fresh and salt water cause similar variations in currents and potentials. It would appear reasonable to expect that water connections considered as electrical conductors are more uniform than land, though this would not always be



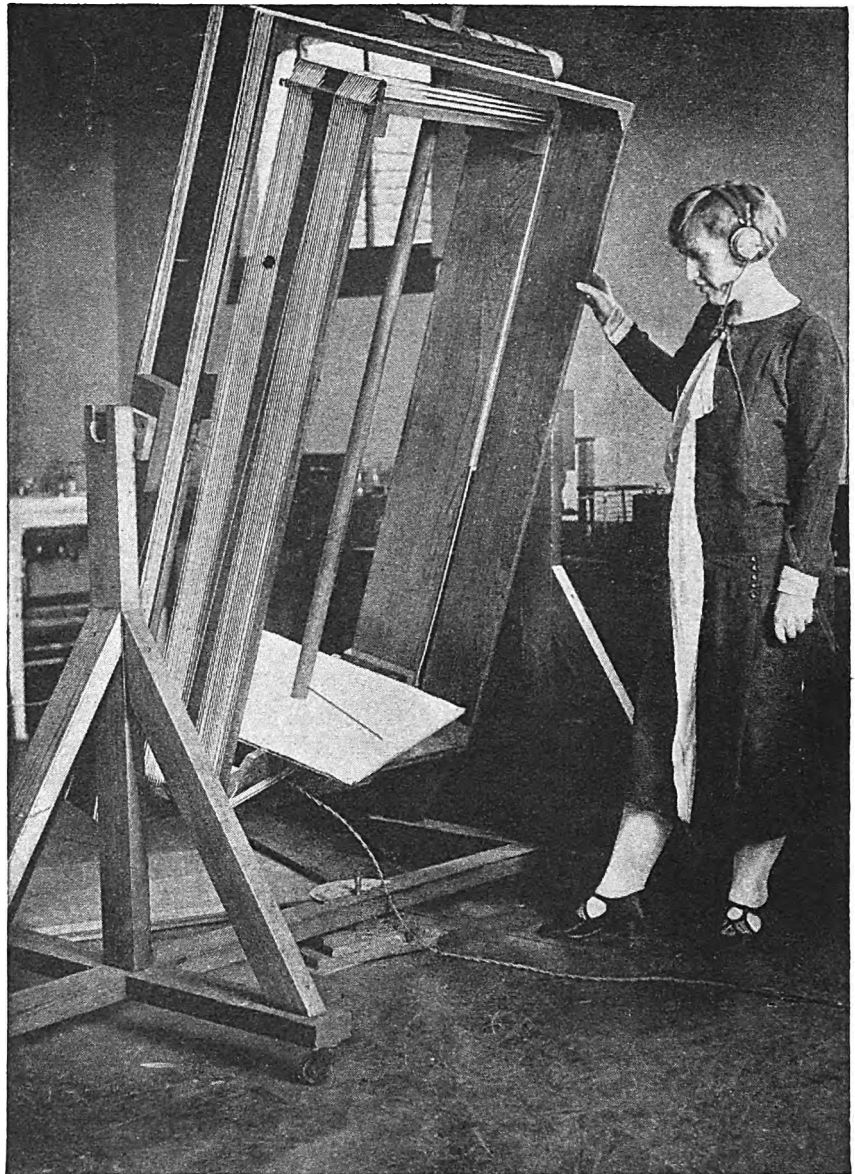
THE APPARATUS FOR THE FIRST EXPERIMENT

FIGURE 1: By means of the apparatus shown diagrammatically above, Dr. Hamer discovered that the current flowing in the galvanometer at the right varied with the air pressure on the earth in the tube. The pressure was varied by means of an aspirator and compressor connected at the top of the glass tube.

the case, especially at the delta of a river.

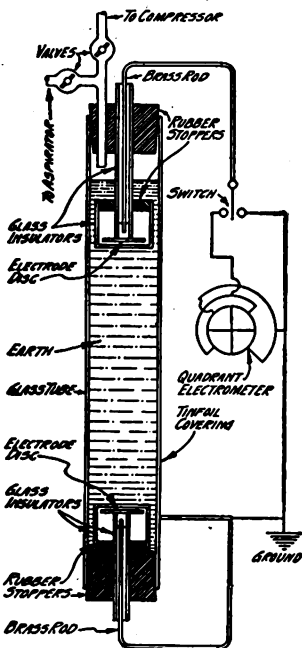
This theory of the cause of static affords a reasonable explanation of the greater prevalence of static in summer than in winter. During the summer months, in the northern hemisphere, pressure changes of short period are more frequent and more sudden than in winter. These are generally due to the prevalence of thunderstorms and similar disturbances. Their period is about half an hour or less and the magnitude is measured in hundredths of an inch of mercury. When condensation, such as rain or fog, takes places, there would be a rapid fall in the pressure and a wave of rarefaction would spread out from the rain area as center. If these pressure changes cause observable temporary disturbances of the electronic or ionic distribution in the earth's crust, then this would give rise to more static in summer than in winter. This is actually the case, as proved by experience.

In winter the pressure changes are of a much longer period, generally about two days, and are much greater in magnitude, being measured by about half an inch of mercury; but since they are more gradual, they are much less likely to be observed as disturbing factors in wireless reception. They should, however, be present as factors in earth-current and magnetic observations. The variations in these should be more or



THESE LOOPS ADD TO OUR KNOWLEDGE OF STATIC

The giant double movable loops pictured here are used by the U. S. Bureau of Standards to determine the direction and intensity of static impulses. It is the theory of Dr. Hamer that static's real lair is in the ground and that it is generated by varying air pressure to which the earth is naturally sensitive.



THE REVISED APPARATUS FOR THE SECOND EXPERIMENT

FIGURE 2: In order to eliminate polarization and resistivity effects that might have been responsible for current changes in his first set-up, Dr. Hamer repeated the experiment, using electrodes insulated from the earth in the tube, as shown above.

less parallel in occurrence and intensity.

Similarly, as regards the daylight hours and the hours of darkness, static and fading effects are more frequent in the former than in the latter. Possibly this is because as far as pressure changes themselves are concerned, a more turbulent state of the atmosphere exists generally during the day than during the night, very short period pressure variations being more frequent.

The experiments with the earthed tube and non-polarizable electrodes support the theory that a redistribution of electrons or ions takes place in the earth's crust when a variation of atmospheric pressure occurs anywhere over the earth. If the electric current due to this redistribution is large enough

to give rise to observable magnetic effects, as would appear from the results so far obtained, then the atmospheric disturbances will play a definite rôle in the magnetic variations, in the same way as it thus appears to be one of the main causes of the variations in the earth currents. Professor Sanford, of the Leland Stanford University of California, has already declared that these magnetic variations parallel those of the earth currents he has observed.

The theory as here proposed suggests that the sun by radiation effects and possibly by gravitational air tides, with the assistance of the moon in the latter case, indirectly causes at least a part of the variations which take place in the earth's magnetic field.



And Now—An AC LC-28

Here is POPULAR RADIO'S premier creation for the professional set builder, the amateur and the music lover. The receiver described in this article embodies all the refinements that place the older model in the front rank of 1928 receivers, with the additional features of complete operation from the AC lighting lines and the best type of amplification and reproduction that it is possible to get at the present time.

By LAURENCE M. COCKADAY

THE new model of the LC-28 receiver described in this article incorporates all the outstanding features of the original set, described in the October, 1927, number of POPULAR RADIO, and in addition several new features and refinements that make it exceptional as a modern receiver for broadcast reception.

First of all, the new set is designed to operate without batteries, utilizing the new AC valves. It may be used with any good quality power amplifier that, in itself, is AC operated and that will furnish "A," "B" and "C" voltages to the LC-28 high-frequency pack itself.

In considering the design of the receiver itself from a theoretical standpoint the reader may refer to the schematic wiring diagram in Figure 3. It will be noticed that the general circuit arrangement is practically the same as

in the DC LC-28. In place of the DC valves, however, are shown three AC filament valves in sockets P1, P2 and P3, while a heater type valve is employed in the detector socket, P4.

In the three high-frequency amplifier stages, O1, O2 and O3, where the straight AC valves are employed, it will be noticed that bridge arrangements, O1, O2 and O3, are used to balance out the AC potential in the grid circuits, carefully by-passed in each stage with suitable by-pass condensers, AA1, AA2 and AA3. The grounded chassis has been utilized for the "C" bias connection to the high-frequency stages, and the center tap on the resistors, O1, O2 and O3, has been raised by the amount of this "C" bias above the chassis potential. This makes a simple but thoroughly efficient job and simplifies greatly the wiring that would ordinarily be used on an AC receiver.

The connections between the high-frequency pack and the power-pack amplifier to be used to operate the complete receiver are laid out with a standard Yaxley cable and plug. Figure 6 shows the connections graphically.

The results that may be obtained with this new receiver are even better than those obtained with the standard DC valves, and set builders who are looking for the latest and most modern type receiver should find it in this new design.

The construction of the receiver is as easy a job as the original DC set, and the results that will be obtained will repay any experimenter. The set is thoroughly reliable and will give results that are really permanent, as the circuits for the AC valves have been carefully worked out with electrical constants that are conservative and that promote long life for the valves.

POPULAR RADIO WORK SHEET

THE LC-28 FOR AC OPERATION

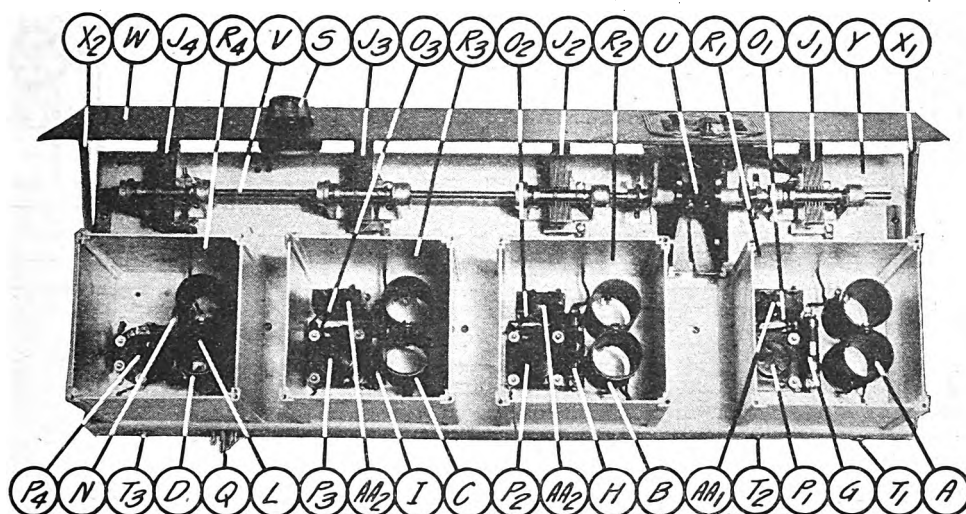


FIGURE 1: THE PANEL LAYOUT OF THE RECEIVER.

LIST OF PARTS FOR BUILDING THE RECEIVER

COST OF PARTS—Not over \$95.00

A, B, C and D—Precision high-frequency transformers, type 4-B;
 E1, E2 and E3—Samson high-frequency chokes, type No. 125;
 F—Samson high-frequency choke, type No. 85;
 G—Lynch suppressor, 500 ohms;
 H—Lynch suppressor, 600 ohms;
 I—Lynch suppressor, 700 ohms;
 J1, J2, J3 and J4—Hammarlund mid-line variable condensers, .000275 mfd.;
 K1, K2 and K3—Aerovox moulded condensers, .02 mfd.;
 L—Aerovox moulded condenser, .00025 mfd.;
 M—Aerovox moulded condenser, .00075 mfd.;

N—Durham metallized resistor, 6 megohms;
 O1, O2 and O3—Electrad center-tapped resistors, Type V-10, 10 ohms;
 P1, P2 and P3—Benjamin 4-prong sockets;
 P4—Benjamin 5-prong socket;
 Q—Yaxley cable connector plug with cable, type 660;
 R1, R2, R3 and R4—Special Junior aluminum box shields for LC-28, made by Aluminum Company of America;
 S—Centralab resistor, 500 ohms, PR500;
 T1, T2 and T3—Carter "Imp" plugs and tip jacks, marked "Antenna" and "Ground," and "Input," respectively, with insulating washers

for the antenna and input jacks;
 U—Hammarlund double-drum dial;
 V—Brass extension shaft, 16½ inches long and ¼ inch in diameter;
 W—Aluminum panel, 6 inches by 26 inches, drilled and decorated, made by Wholesale Radio Service Company;
 X1 and X2—Tait brackets;
 Y—Aluminum chassis for the LC-28, made by the Aluminum Company of America;
 Z—Lynch single-resistance mounting;
 AA1, AA2 and AA3—Acme Parvult bypass condensers, ½ mfd.;
 Corwico Braidite hook-up wire, screws, nuts, 1½-volt flashlight bulb, solder, etc.

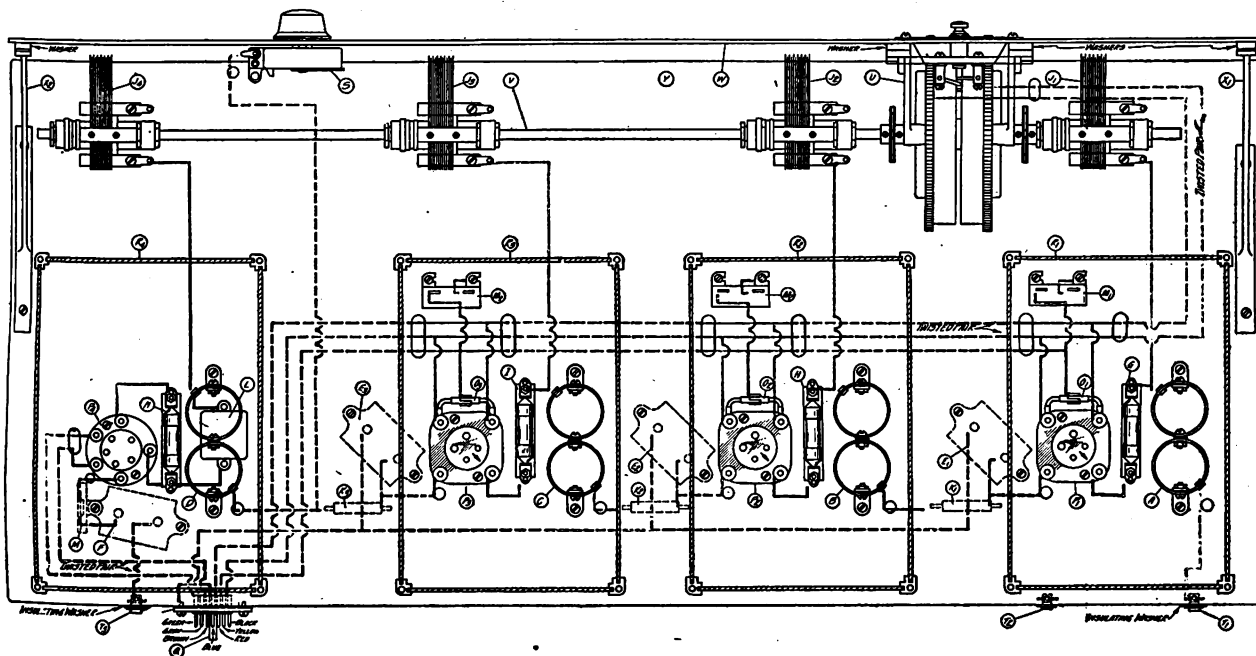
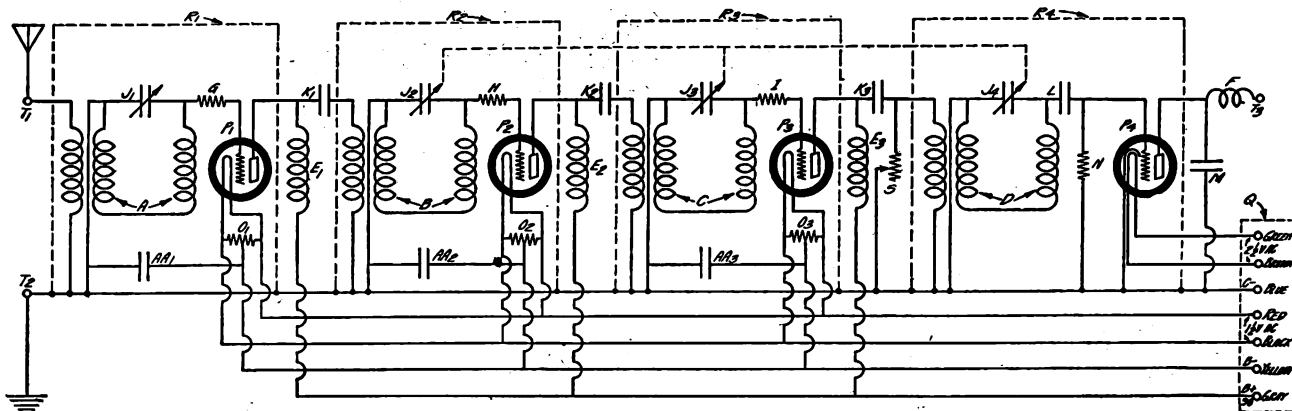


FIGURE 2: THE PICTURE WIRING DIAGRAM OF THE RECEIVER.



THE SCHEMATIC CIRCUIT OF THE NEW RECEIVER

FIGURE 3: A comparison of the circuit shown above with that of the DC-wired LC-28, described in the October, 1927, number of POPULAR RADIO, will show how simple is the new circuit arrangement for using AC valves. This simplicity is the result of intensive study of the problems involved in the use of alternating current as a power source.

The Construction of the Receiver

In building the receiver, the same general construction features should be followed as were outlined in detail in the October, 1927, issue of POPULAR RADIO.

The first job is to mount the instruments on the chassis in the holes drilled for them, as shown in Figures 1 and 4. Then fasten on the front panel and the shields, leaving off the covers of the latter. The detailed information given on this subject in previous articles need not be repeated here.

The addition of the by-pass condensers, AA1, AA2 and AA3, necessitates drilling a few extra holes in the chassis. One extra hole for the pilot light wiring and one for the extra jack are also necessary. The information for drilling the extra holes is given in the

diagram in Figure 4. The by-pass condensers, AA1, AA2 and AA3, are mounted in front of the sockets, and the tapped resistors, which are V-shaped, are connected to the two filament terminals of each of the three high-frequency sockets, with the center terminal sticking up. These are indicated in the picture wiring diagram in Figure 2.

How the Set Is Wired

As with the first design of this receiver, the wiring is accomplished, in as many cases as possible, by the mere act of fastening down the various parts onto the metal chassis. This feature eliminates a good many feet of wiring and simplifies the connections so that any novice can accomplish the job. The complete set should be wired up with a heavily braided, insulated wire,

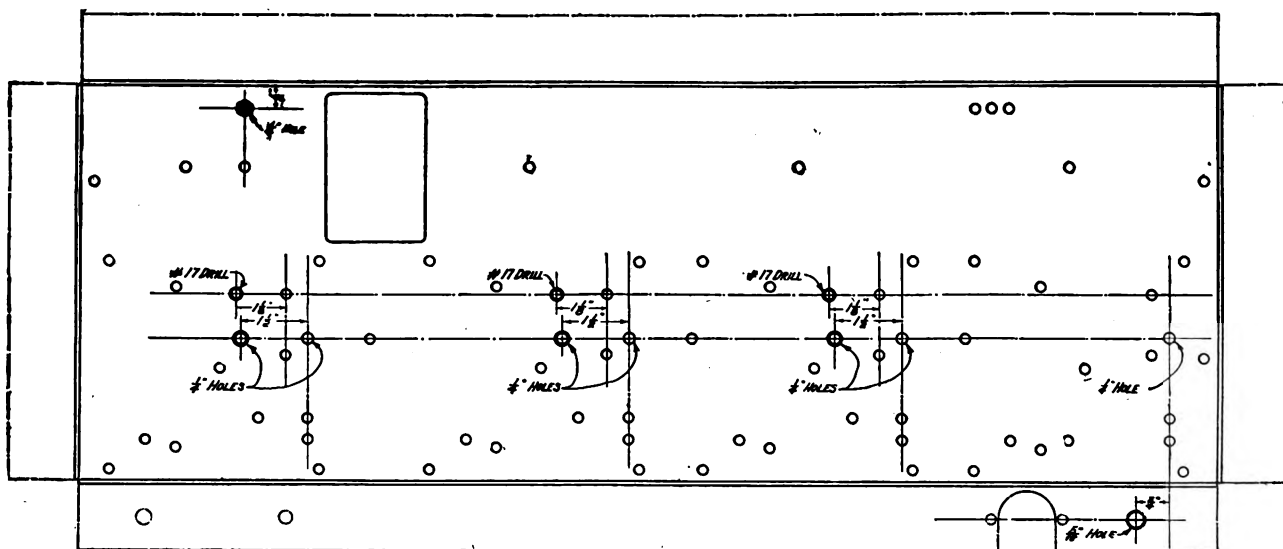
such as Corwico Braidite hook-up wire.

If the set builder will refer to the picture wiring diagram in Figure 2 for the correct connections, he will make no serious errors.

It will be noticed that the wiring of the 1½-volt AC filament circuit from the Yaxley cable to the AC filament circuits of the three high-frequency valve sockets, P1, P2 and P3, and the connections to the pilot light are made with a double piece of hook-up wire twisted between each connection. This is shown very clearly in Figure 5. The same holds true of the 2½-volt AC connections from the Yaxley plug to the heater terminals of the 5-prong detector socket, P4.

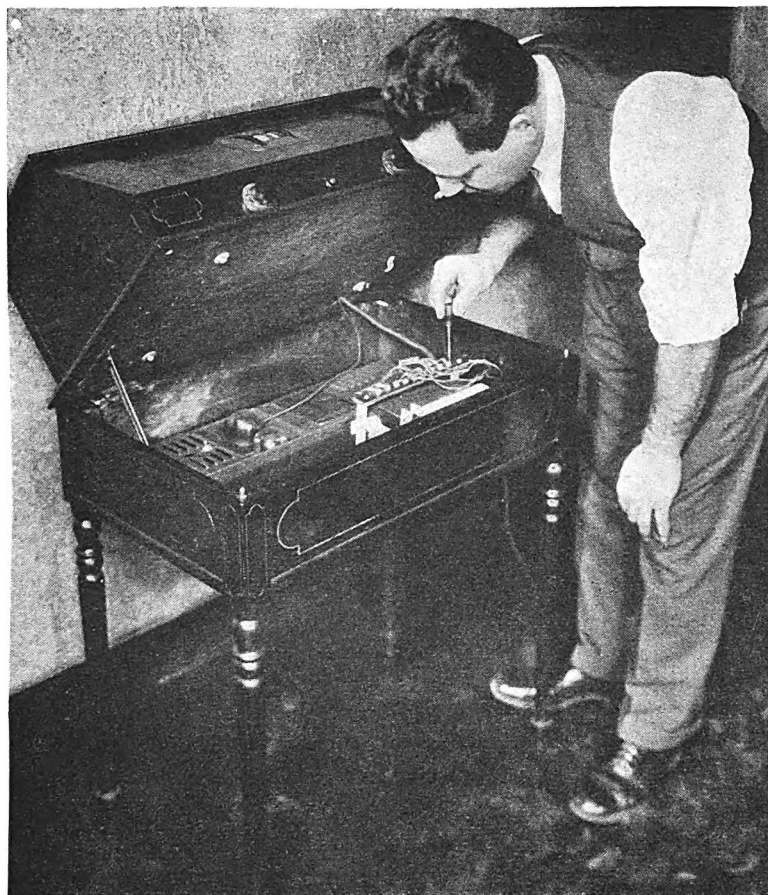
In connecting up to the pilot light, the contact arm assembly is left off

(Continued on page 246)



THE CHANGES NECESSARY IN THE LC-28 SUB-PANEL

FIGURE 4: The holes drilled in the original LC-28 sub-panel are shown in light black circles. The heavy black circles indicate the new holes which must be drilled for the assembling and wiring of the AC model of the receiver. Note that four of the old holes are redrilled so as to be ¼ inch in diameter.



PUTTING THE CONDENSER UNIT IN PLACE

In the lower battery compartment of the Radiola 28 the power unit and the condenser unit are placed as shown here; once installed they require no further attention.

PUT THIS "ABC" POWER BOX IN YOUR RADIOLA 28

By ROBERT W. TAIT

RADIO fans who now own a battery-operated Radiola 28 receiver will be interested in learning that they can convert it to complete AC operation in a few minutes' time, as outlined in this article.

This conversion is made possible by an AC power-pack kit containing the parts listed in the list of parts given here:

- A—Power unit;
- B—Condenser unit with terminal board;
- C—7-wire cable;
- D—4-wire cable;
- E—Resistance strip;
- F—Resistance rods;
- G—Transfer plug;
- H—Stirrups for mounting power unit;
- I—Roundhead wood screws.

The AC adaption comprises changing over the filament wiring of the receiver by means of a cable, indicated in Figure 1 as C.

This change may be divided into four simple operations, as follows:

1. The removal of the operating panel.

Complete socket operation for the Radiola 28 may now be accomplished by any fan in a very short time with the simple apparatus described here. In addition to doing away with the annoyances of battery operation, the change-over apparatus incorporates a 210 type valve power stage for the low-frequency amplifier.

2. Changes in the receiver unit.
3. Changes in the cabinet.
4. The replacement of the cabinet.

The Removal of the Operating Panel

The first job is to take the loop antenna out of its socket and remove all the vacuum valves from their sockets.

Then raise the upper section of the cabinet so that it will remain open, revealing the battery compartment in the lower portion. Disconnect all the batteries and remove them from the lower compartment.

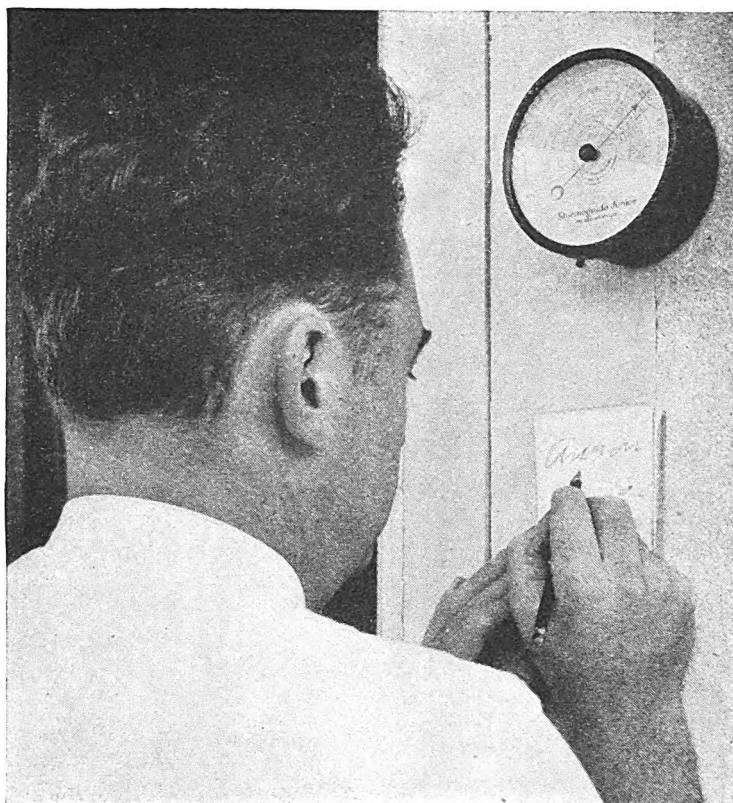
Now unscrew the four screws and lock washers on the bottom side of the raised section and then lower the top section.

When this is done, the upper lid should be raised and the complete panel assembly may be pulled out gently, about three or four inches. All of the screws holding the terminals of the battery cable at the rear of the sockets may now be loosened and the cable and its terminal strip removed. The receiver unit may then be completely taken out of the cabinet. Next remove the condenser in the upper right-hand corner of the cabinet and unfasten the clamps fastening the cable to the cabinet.

(Continued on page 254)

READING THE RADIO FUTURE

By the use of the simple and easily read aneroid barometer shown at the right, the possibilities of good or bad reception for the next twelve hours may be predicted with remarkable accuracy.



THREE SIMPLE INSTRUMENTS THAT WILL HELP YOU IN FORECASTING STATIC

Here is a way for any fan to become a radio reception "prophet," with the aid of the three easily purchased and easily manipulated instruments described below. And there is great entertainment—and also a field for real scientific endeavor—in tracing the periodic weather conditions that are responsible for changes in radio reception.

By EUGENE VAN CLEEF

THAT radio reception fluctuates in quality with the variations in our atmospheric conditions seems certain. Some attribute to the weather too much influence on radio reception, and others now are ready to say that atmospheric conditions play no part. A number of persons have suggested a sun-spot influence, but according to recent press dispatches those in charge of investigations of the sun-spot relationships declare this theory exploded. In the face of these contradictory views, the writer is convinced, after a long period of observation, that the degree of static which interferes with our radio reception varies with atmospheric conditions—more particularly with *pressure*. Assurance of this relationship is based upon the correlation of reception conditions with the daily passing high and low pressure

areas. The relationship is so clear-cut that definite statements may be set up which will serve as guides to those desirous of forecasting daily the probability of static. Before recording these conclusions we should first note the nature of Highs and Lows and some facts regarding their behavior.

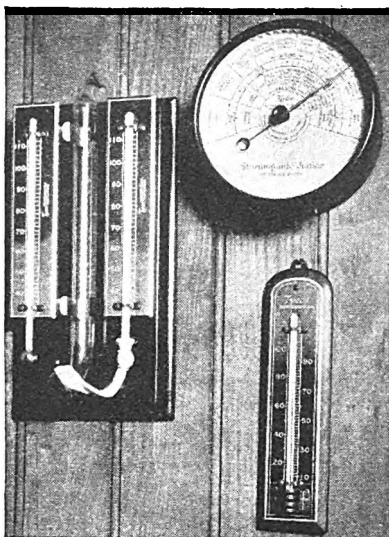
If the reader will secure successive weather maps like that in Figure 2, and watch a given high pressure area on successive days, he will note that it moves across the country normally at about the average speed of a passenger train, so that in the course of about four 24-hour days it travels from the Pacific coast to the Atlantic. Accompanying the High is a Low which travels at about the same rate. No two Highs nor two Lows occur next to each other. The Highs and Lows generally

occur in pairs, a High following a Low, or a Low following a High.

These passing pressure areas, or "storms," as the Weather Bureau sometimes designates them, indicate the nature of the weather which any locality is likely to have. Since they always travel in an easterly direction, and since their rate of motion is known, we can forecast the weather for a given locality if we know what the pressure and accompanying weather conditions are to the west, as shown by these areas. Space limitations do not permit of a detailed account of the special problems associated with the fascinating field of weather forecasting, but enough perhaps has been said to direct attention to the occurrence of these pressure areas which seem to be so intimately associated with our static troubles.

Some persons may already have acquired the impression that the situation here noted is too complicated for them, and consequently at this point are ready to give up the idea of forecasting for themselves. These fears, however, need not be further entertained, as the operation of forecasting may be reduced to fairly simple terms. One does not need to subscribe for the daily weather map, as desirable as that is for minute investigation, but can accomplish much in this work with the aid of three simple instruments—the barometer, outdoor thermometer and hygrometer.

Just what is a barometer and what does it tell? We have learned by experiment that at sea level on a normal day the atmosphere weighs 15 pounds to the square inch. This weight we call pressure. If a glass tube about 34 inches long were filled with mercury and the open end immersed in a cup of mercury, the mercury within the tube under the conditions just noted would fall to a height of 30 inches above the level of the cup basin. In other words, the weight of the column of mercury within the tube would equal the weight of the air pressing outside upon the mercury surface in the cup. This weight represents the air pressure and the length of the column is



THE THREE TOOLS OF THE RADIO PROPHET

FIGURE 1: At the left is a hygrometer, by which the relative humidity of the atmosphere is determined. At the lower right is an ordinary outdoor thermometer, and at the upper right is an aneroid barometer, which registers the air pressure at the moment and thus gives warning of approaching Highs and Lows.

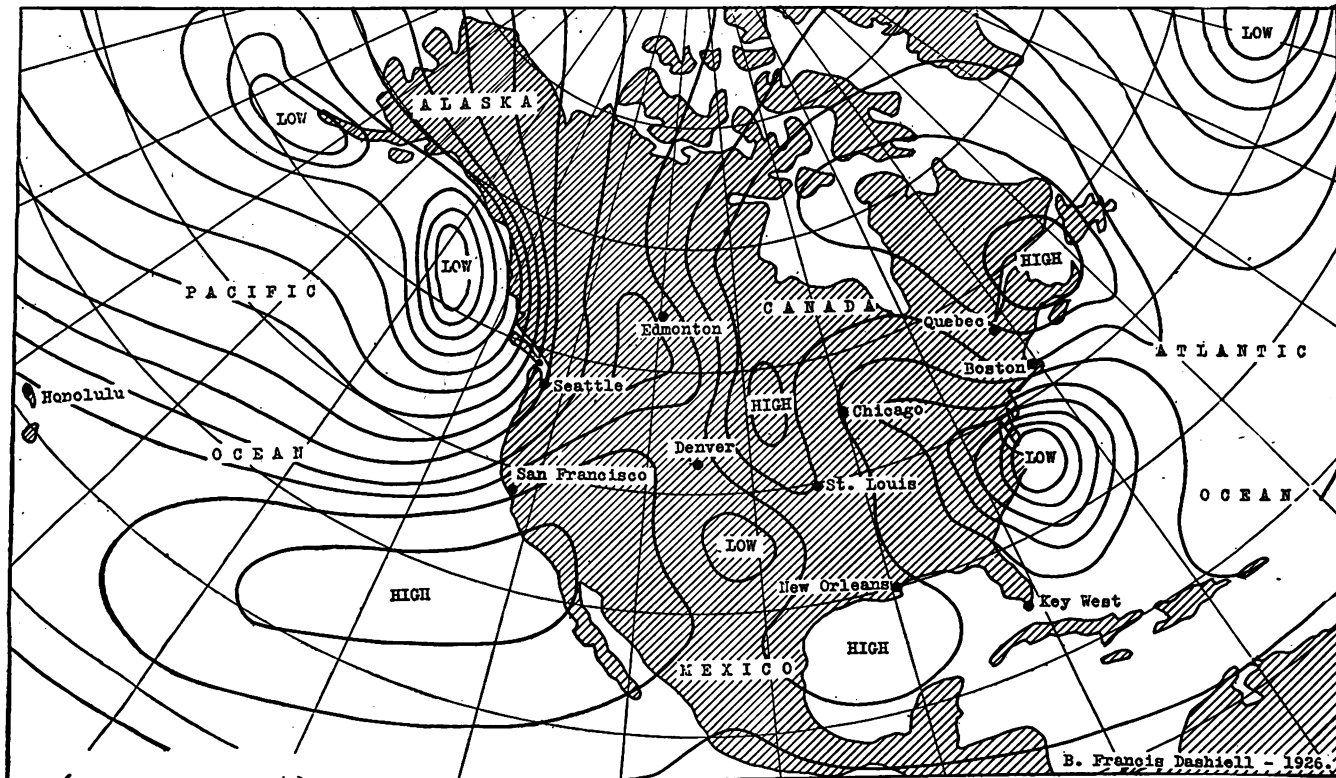
interpreted as the air pressure. An atmospheric pressure of 30 inches has been adopted as normal. If the height of the mercury column rises above 30

inches, the pressure is high; if it falls below 30 inches it is low. On the weather map the Highs and Lows to which we have referred mean exactly this.

The mercurial barometer is too expensive for most of us to possess and, furthermore, is rather awkward for a novice to use. So in its place the compact and convenient aneroid barometer, in which air is utilized, is recommended. It is calibrated according to the readings of the mercurial barometer, and is so arranged that anyone can read it easily and note whether or not the pressure is rising or falling.

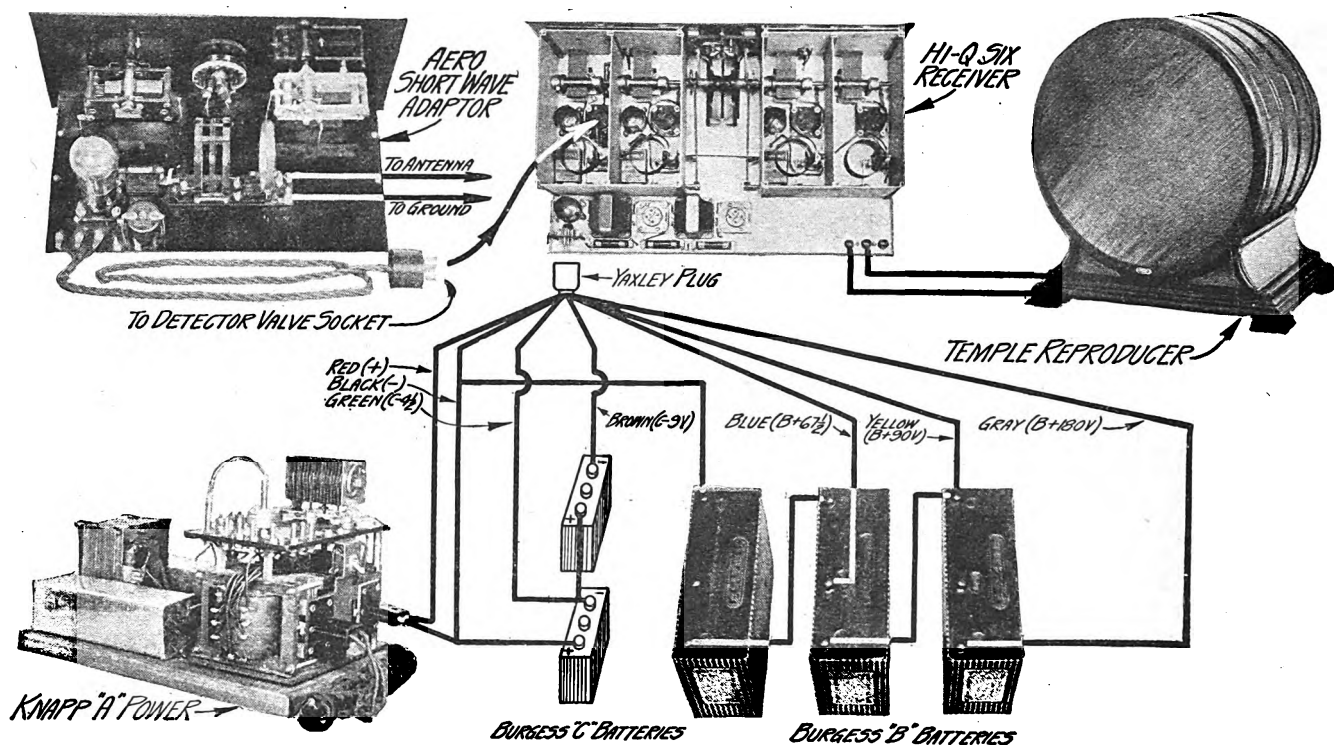
Generally if the pressure reads above 30 inches static will be absent, and if below it will be present. If the barometer is just below 30 inches in the morning and has been rising all the preceding night, the prospect of no static for the evening is excellent. If, on the other hand, the reading is just above 30 inches and the pressure has been falling during the preceding twelve hours, then static is almost certain during the next twelve hours. That is simple enough; but exceptions creep in occasionally, and to make allowances for them the outdoor thermometer and hygrometer will assist us.

Everyone is familiar with the use of
(Continued on page 242)



HOW GOOD AND BAD RECEPTION FOLLOW THE WEATHER

FIGURE 2: In this weather the solid lines, or isobars, connect places of equal air pressure, and indicate in this way the positions of high and low pressure areas for a given time. Note that severe storms, with accompanying static, are indicated by the very low pressure areas on the northwest and eastern coasts, while the central part of the country is enjoying the good reception that generally accompanies high-pressure areas.



A HOOK-UP FOR BRINGING IN THE SHORT WAVES

FIGURE 1: In the photo-diagram above, the Hi-Q "Six" is shown as an example of standard broadcast receivers with which the Aero converter may be used for bringing in short-wave broadcasts. The converter draws all its plate and filament currents from the units that supply the receiver.

Any Receiver Brings In Short Waves With The Aero Converter

With the interest in short waves mounting daily, radio fans will welcome the constructional data given below for building a simple unit which will bring all the short wave-bands into the range of their broadcast receivers. The Aero converter is less expensive and easier to build than an ordinary receiver, and its operation does not require the addition of any batteries or power-packs whatsoever.

By CARL DORF

RADIO fans are turning their attention more and more toward the fascinating short waves, with which remarkable distances may be covered, and static, the great destroyer of reception, is practically eliminated.

There are now many short-wave stations within the range of even a simple converter of the type described in this article. The new field of reception opened up by this device will prove a revelation to the broadcast listener.

Reception of short waves may be accomplished by simply inserting the connector plug of the short-wave adaptor described here into the detector socket of any standard broadcast receiver.

The new adaptor unit consists of a regenerator detector circuit equipped with a triple coil unit consisting of an antenna coil mounted on a variable coupling and a set of three detachable coils that plug in for the various wavelength ranges that are to be covered. Each detachable coil consists of a secondary coil and a tickler coil of the correct size for the band that it is designed to cover. The tuning is controlled by two variable condensers; one tunes the coil to the proper frequency or wavelength and the other is used to control regeneration. These two condensers are mounted on the front panel, along with a variable resistor for oper-

ating at the correct filament temperature.

The complete job may be assembled and wired in less than one hour.

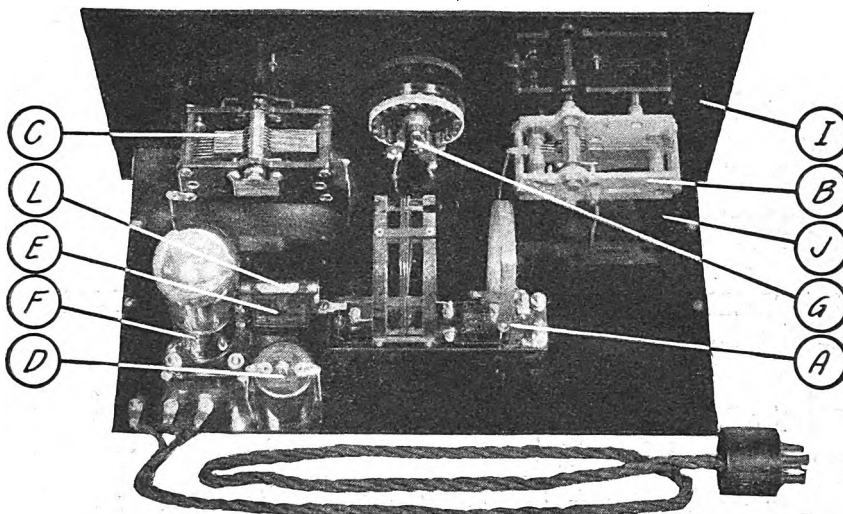
How to Assemble the Instruments

The best plan is to start mounting the instruments that are to be attached to the sub-panel, J. Figure 2, which is a top view of the adaptor, shows the relative positions for mounting the various instruments. The layout of the instruments is also shown in the picture wiring diagram in Figure 3. The construction will be a simple job, as there are only a few instruments to be mounted. It will be best to use

(Continued on page 263)

POPULAR RADIO WORK SHEET

THE AERO SHORT-WAVE CONVERTER



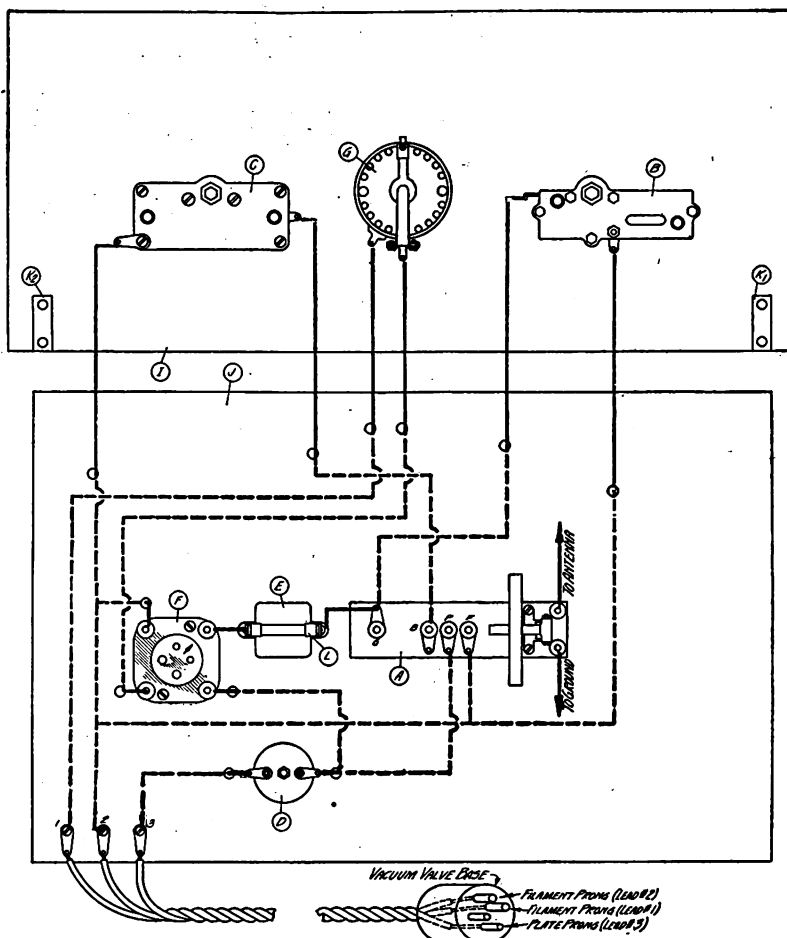
HOW THE INSTRUMENTS ARE MOUNTED

FIGURE 2: As this view shows graphically, the complete job of mounting and wiring the instruments of the converter is extraordinarily simple, and could be completed by any novice in very short order.

LIST OF PARTS FOR BUILDING THIS UNIT

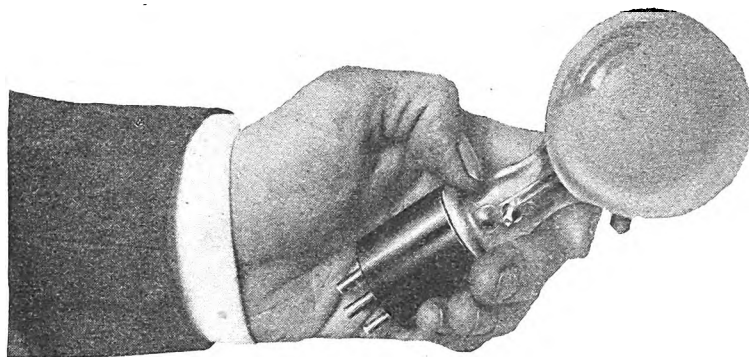
COST OF PARTS—Not over \$33.00

- A—Aero short-wave tuner, type LWT-125;
- B—Amsco variable condenser, .00014 mfd.;
- C—Amsco variable condenser, type 514, .00025 mfd.;
- D—Aero high-frequency choke coil, No. 60;
- E—Carter moulded condenser, .0001 mfd., with grid-leak clips;
- F—Benjamin 4-prong socket;
- G—Yaxley rheostat, 25 ohms;
- H1 and H2—National type B dials;
- I—Westinghouse Micarta drilled panel, 7 by 14 by $\frac{1}{8}$ inch;
- J—Westinghouse Micarta drilled sub-panel, 7 by 13 by $\frac{3}{16}$ inch;
- K1 and K2—Aero sub-panel brackets;
- L—Tobe Tipon grid-leak, 5 megohms;
- 5 feet Celatsite insulated bus bar, old valve base, screws, nuts, etc.



HOW THE CONVERTER IS WIRED

FIGURE 3: The wires are indicated in red lines, solid for wiring above the sub-panel and dotted for wiring below. The detail at the bottom of the diagram shows exactly how to wire the discarded vacuum valve base that is used to plug into the detector socket of the broadcast receiver with which the converter is used.



Radio's New Organ of Sight

Around the simple glass bulb with the vacuum valve base shown at the left have been built all the marvelous achievements of television that have so startled the world of late. Science can now make these photo-electric cells so sensitive to light that the glare of a match will destroy them.

HOW SCIENCE PERFECTED THE PHOTO-ELECTRIC CELL AND PROVIDED

Radio's "Sixth Sense"

How many people know just what a photo-electric cell is, how it functions, what principles underlie its action, or how it is applied to television? In this and in succeeding articles all these questions will be answered, and the whole fascinating story of photo-electric science and its development told.

Article No. 1

By DR. LEWIS KOLLER

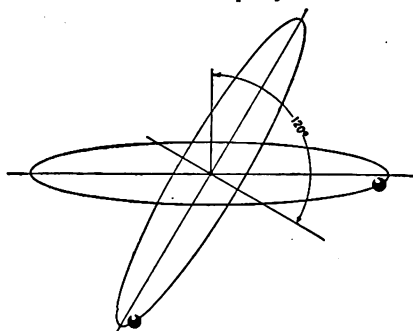
Research Laboratory, General Electric Company

FEW scientific developments have ever caught the public imagination as quickly as the experiments in television which have been carried on during the past few years. These experiments, together with the successful use of talking moving pictures, have at last brought to the attention of the public a once little-known branch of electricity—photo-electricity, the science that treats of the relationship between light and electricity.

Most of the interest in photo-electricity has centered about the photo-electric cell, a vacuum valve device by means of which light can be made to control electric current. It has many uses in addition to television and talking moving pictures, such as in photometry, cigar sorting, control of paper quality, and control of street and sign lighting.

The development of the cell to the point where it is a reliable, reproducible, readily available device has opened up a new and fascinating field for the professional and amateur experimenter alike. And yet few people who are not experts on the subject know much about the history of the cell, the fundamental principles involved in its operation, or its manufacture in its present-day form. Yet these facts make a vastly interesting story.

The fundamental action of the photo-



HOW SCIENCE PICTURES THE LITHIUM ATOM

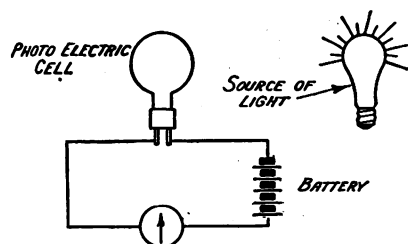
FIGURE 1: *The planetary nature of the atom is clearly shown in this diagram. The lithium atom is quite simple in its construction, with two electrons revolving in their orbits around a central proton. Complex atoms, such as those of some of the metals, have many more electrons revolving about the positive proton.*

electric cell is illustrated by the diagram in Figure 2. A cell is connected in series with a "B" battery and a milliammeter. Light from an incandescent lamp falls upon the cell. The nearer the light is to the cell, the larger the current flowing through it, as can be shown by moving the light back and forth. If the distance between light and cell is measured at the same time that the meter is read, it will be found that the current varies inversely as the square of the distance, showing

that the activity of the cell is directly proportional to the amount of light falling upon it.

The vacuum valve photo-electric cell is a comparatively recent development. Its forerunner was the selenium cell. The element selenium was discovered by the Swedish chemist, Berzelius, in 1817. In 1873 an Englishman, Willoughby Smith, attempted to use selenium in making high resistances for use in transatlantic telegraph work. He found that these resistances were very erratic and changeable, and eventually discovered that this was due to the fact that the electrical resistance of selenium depends upon the amount of light falling upon its surface. The brighter the light, the lower the resistance of the metal. Smith was able to get around his difficulties by enclosing his resistances in a light-tight box. Following this discovery, cells were constructed of many different forms to make use of this interesting property. The selenium cell is still in use for some purposes, although it has many undesirable properties.

The action of the type of photo-electric cell that I am going to describe, however, is radically different. The underlying principle was first made clear by the German physicist, Hallwachs, in 1888. Hallwachs discovered that if he charged a zinc plate to a neg-



A SIMPLE PHOTO-ELECTRIC CELL CIRCUIT

FIGURE 2: The fundamental action of the photo-electric cell can be determined from such a set-up as this. The amount of current flowing in the milliammeter varies inversely as the square of the distance from the cell to the light source, showing that the current increases or decreases directly with the amount of light falling upon the cell.

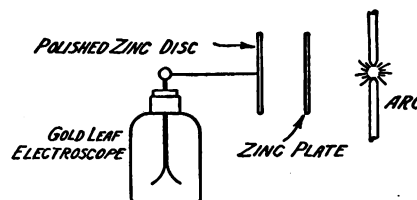
ative potential (by connecting it to the negative terminal of a battery) and then exposed it to ultra-violet light; it gradually lost its charge. When he exposed the plate in the same way after first raising it to a positive potential, it did not lose its charge. This phenomenon has been thoroughly investigated and it has been found that practically all substances exhibit it to a greater or lesser degree. This is the fundamental phenomenon of photo-electricity.

Figure 3 shows the experimental arrangement used by Hallwachs. He had a polished disc of zinc 8 cm. in diameter. In front of this was a large shielding plate of zinc, 60 x 70 cm., with an opening in which could be placed windows of various materials. The zinc disc was illuminated by the light of the arc lamp in front of the windows. The gold leaf electroscope connected to the disc tells what is happening to the charge on the plate. When it is charged with electricity the leaves stand out away from each other, and as the charge leaks off the leaves gradually collapse. Hallwachs found that when the plate was negatively charged

the electroscope leaves stood out until light from the arc fell upon the plate. They then began to drop, showing that the charge was leaking off the plate. No such change was observed when the plate was positively charged.

The explanation in terms of present-day physics is simple. The light which is absorbed by the photo-sensitive surface causes the emission of electrons or negative charges. If the plate is negatively charged to begin with, these electrons are able to escape and so the plate loses its charge, while if it is positively charged they are unable to escape because of the positive potential of the plate, and it thus remains charged.

Perhaps before going further into the subject it would be well to say a little about the electron and modern views of the constitution of matter. The earliest conception of the atom was simply the smallest particle of matter that could exist. If one took a small piece of matter and cut it in two; took one of the halves and cut that in two, and so on, eventually one would reach a very tiny piece of matter that could not be any further subdivided. This was the atom. Now through the work of Thomson, Rutherford, Bohr and many others we have a picture of a vastly different structure which has much evidence to confirm it. Atoms are now believed to be small planetary systems with a massive nucleus in the center like our sun, and rotating about this center a number of electrons like the planets. The nucleus, which carries the positive charge, is made up of atoms of hydrogen, or protons, packed closely together. The electrons are nothing other than negative charges of electricity. The force of attraction between the positive and negative charges holds the system together, just as the gravitational forces hold our solar sys-



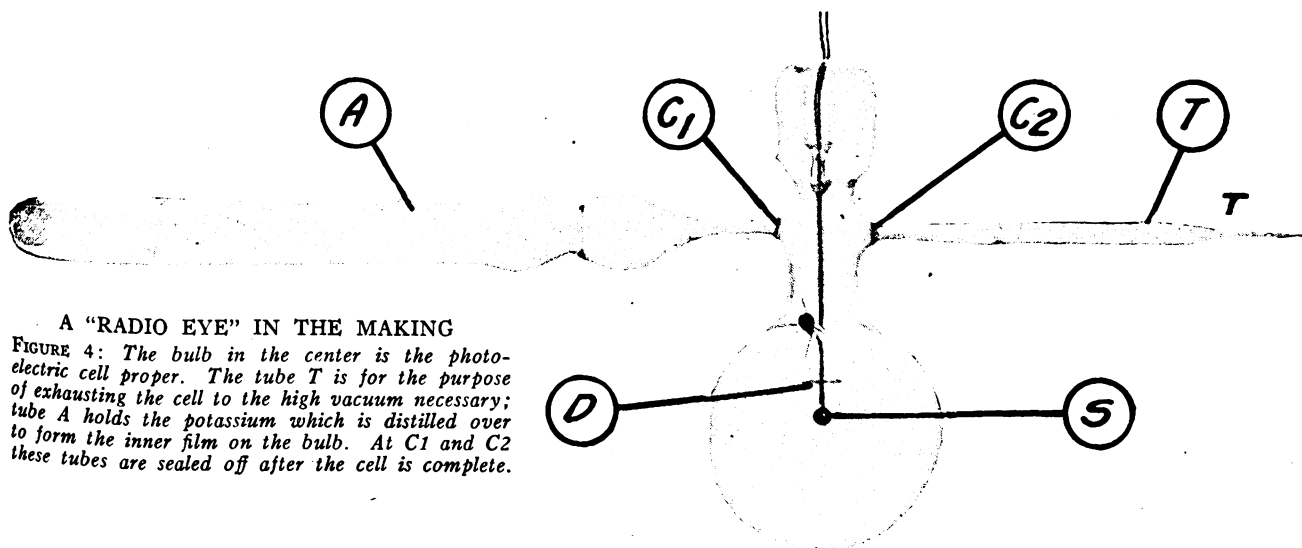
HOW PHOTO-ELECTRIC ACTION WAS DISCOVERED

FIGURE 3: In the original experiment, light from the arc fell through a window in the zinc plate on the polished disc connected to the electroscope. When the electroscope was positively charged, this light produced no change, but when it was negatively charged, the light caused the leaves to fall, showing the charge was leaking off the zinc disc.

tem together. Thus the atoms of all substances are made up of the same ultimate units, protons and electrons. The differences between different kinds of matter are due to the different arrangements of these two kinds of building material. Figure 1 shows the structure of one of the simpler chemical elements, lithium. This theory has met with great success in predicting the spectra produced by the different elements.

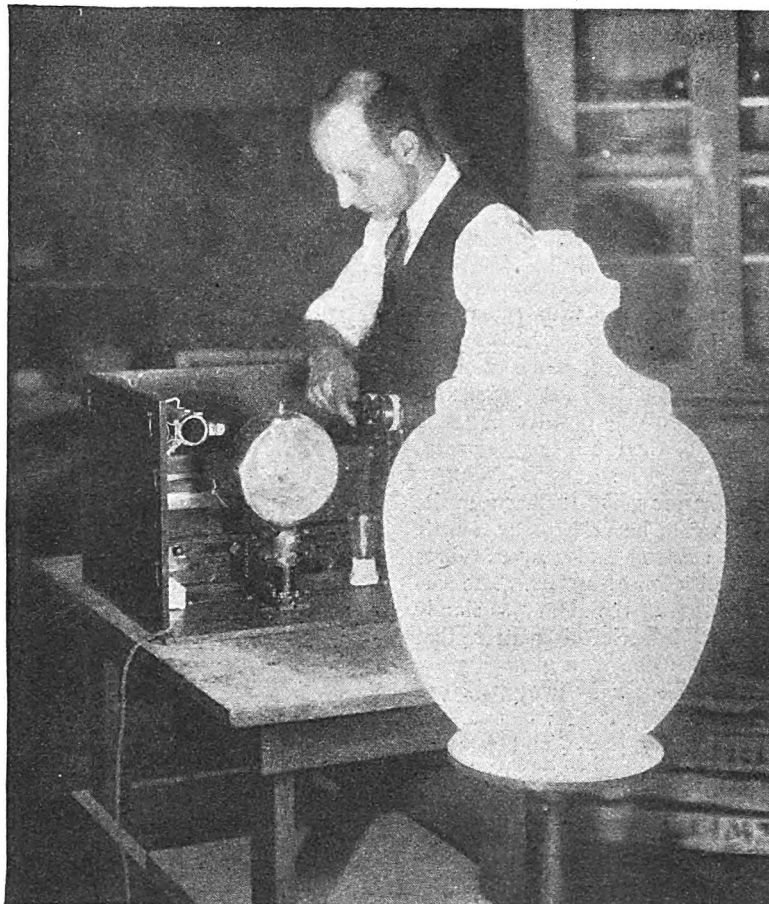
All matter, then, is made up of atoms like these. Some kinds of matter, notably the metals, have the power of readily conducting a current of electricity. We believe that in conductive elements there are a large number of free electrons—electrons in addition to the rotating electrons which are attached to each individual atom—and that these are free to wander through the metal in accordance with the impressed electric forces. It is the actual motion of these electrons that constitutes an electric current.

To return to the photo-electric cell, it can be represented diagrammatically as shown in Figure 5. Light falls upon the surface of the metal plate, P, and



A "RADIO EYE" IN THE MAKING

FIGURE 4: The bulb in the center is the photo-electric cell proper. The tube T is for the purpose of exhausting the cell to the high vacuum necessary; tube A holds the potassium which is distilled over to form the inner film on the bulb. At C1 and C2 these tubes are sealed off after the cell is complete.



TESTING THE ACTION OF A PHOTO-ELECTRIC CELL

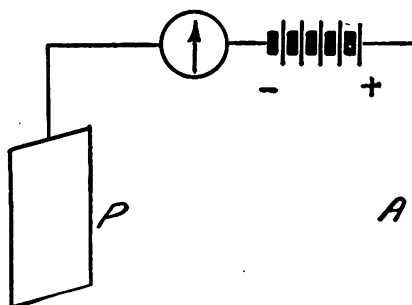
By means of this apparatus, the electrical characteristics of the photo-electric cell may be accurately determined. The light from the large lamp in the right foreground falls on the cell in front of the man, and the current changes may be read from the meters in the testing box.

causes photo-electrons to be emitted from it. The plate is connected to the negative terminal of a battery and the wire, A, is connected to the positive terminal. The positive charge on A draws the electrons across the space and so a current flows through the circuit. The electrode which emits the electrons must always be connected to the negative battery terminal, and is called the cathode. The positive electrode is called the anode.

This is purely a diagrammatical representation of a photo-electric cell. A more usual form is shown in Figure 4. The inside of the glass bulb is silvered and contact is made with the silver surface by means of a platinum flush seal. This silver surface is coated with a thin layer of some material such as one of the alkali metals, lithium, sodium, potassium, rubidium and caesium, which are particularly photo-sensitive. This takes the place of the plate of Hallwach's experiments. The other electrode projects through the base into the center of the bulb. A circular opening in the silver coating serves for the admission of the light. Details of construction may vary, but the essentials remain the same.

struction may vary, but the essentials remain the same.

For those not familiar with high vacuum technique, the method of preparation of a cell will be of interest. Figure 4 shows the cell ready to be exhausted. It is sealed onto the exhaust system by means of the tube T. The exhaust system consists of two pumps



A SCHEMATIC REPRESENTATION OF THE CELL

FIGURE 5: Light falling on the plate, P, of the photo-electric cell causes it to emit electrons, since it is negatively charged by the battery. The positively charged terminal, A, draws these electrons to it, and causes a current to flow in the circuit whenever light falls on P.

connected in series, a mercury vapor pump and a rotary oil pump, which works into a rough vacuum line. Between the cell and the mercury vapor pump is a liquid-air trap. The end of this trap is cooled by being immersed in liquid air at a temperature of -185°C ., and any water or mercury vapor present is condensed on the cold walls of the trap. An electrical or a gas-heated oven is pulled down over the cell in order to heat the glass walls thoroughly and free them of water vapor and other absorbed gases. By this means the vessel is pumped down to a vacuum of a few hundredths of a micron, or about one one-hundred-millionth of an atmosphere. A McLeod gauge provides an easy and accurate means for measuring pressures of this order of magnitude. The next step is to silver the bulb. This is done by passing a current through the molybdenum spiral, S, which carries at its tip a small bead of silver. The heat causes the silver to evaporate and the silver atoms condense on the relatively cool bulb wall, thus providing the mirror-like silver coating. Since the atoms travel in straight lines, the little disc, D, causes a circular shadow where the silver has been prevented from reaching the bulb wall. This shadow forms the cell window. The potassium in the side arm, A, is now distilled over into the bulb by warming gently with a torch. The side arm is then sealed off by heating at the contraction, C1, and the cell is sealed off from the pump at C2 in the same way.

In some cells the sensitive surface is made of potassium hydride. This is formed by admitting a low pressure of hydrogen into the cell just before sealing off and passing a glow discharge between the electrodes for 15 or 20 minutes. This converts some of the potassium to potassium hydride.

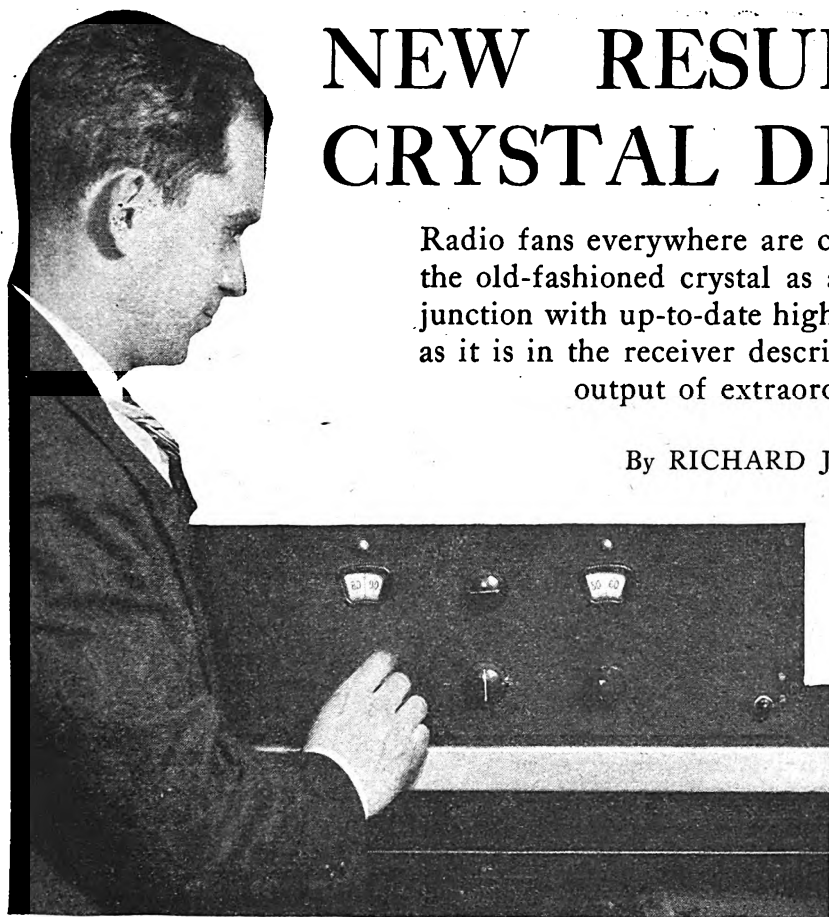
Where the sensitive surface is of caesium it is introduced in still a different way. A mixture of caesium chloride, and calcium filings is placed in a little nickel capsule or pellet and enclosed in the side arm. When this is heated by means of a high-frequency induction furnace, these two substances react and very pure caesium distills out into the bulb. Caesium cells have been specially treated so as to give a sensitive surface of caesium only one atom deep.

The particular value of the photo-electric cell lies in the fact that the current passing through it is directly proportional to the quantity of light falling upon it. Doubling the light doubles the current, etc. For this reason the cell can easily be used for measuring changes in light intensity.

NEW RESULTS WITH CRYSTAL DETECTION

Radio fans everywhere are coming back to the use of the old-fashioned crystal as a detector. Used in conjunction with up-to-date high-frequency amplification, as it is in the receiver described below, it delivers an output of extraordinary quality.

By RICHARD J. GRIFFITH



IN designing a radio receiver, it is always necessary to make some sort of compromise between conflicting excellences in receiver design. It is well known, for instance, that we cannot get the greatest possible selectivity without sacrificing quality, so that it is necessary to compromise between the two. Likewise, it is extremely difficult to design a receiver of extremely great sensitivity without destroying some of its tone quality.

In spite of these considerations, the present receiver is offered to the set builder as a close approach to the ideal set for ordinary use. It has to offer fine tonal quality and high selectivity, and it will give a good account of itself in distance reception. Added to this, it may be made regenerative or non-regenerative as the operator desires, simply by turning a knob in the rear of the set, without any delicate or critical adjustments.

While the high-frequency system uses three vacuum valves and gives sensitivity equal to three stages, it will be noted that it is controlled by only two dials, and does not require any ganging of condensers to accomplish this.

A carborundum detector is used for rectification, and this has been simplified so that no extra battery is re-

quired, the necessary biasing voltage being secured from the plate circuits of the high-frequency valves.

The low-frequency system consists of one transformer, one resistance and one transformer-coupled stage, in the order named. The transformers are of the quality type and are coupled with the resistance-coupled stage, giving excellent tone quality. The last stage employs a power valve with an output filter, so that the full volume delivered by the set can be put to use without overloading. The schematic diagram of the circuit is shown in Figure 2.

The battery connections have been simplified, so that there are no intermediate taps from either the "B" or the "C" batteries. The proper voltages are secured through the use of resistances in the set, and as a result it is only necessary to attach the full "A," "B" and "C" voltages to the set.

The Construction of the Set

The first step in the construction of the set is to prepare the panel, X1. A great deal of trouble may be saved by procuring the panel already drilled and finished. Next, the instruments are mounted upon it; but, before so doing, the condensers, C and D, are mounted upon the dial controls, T1 and T2, in such positions that the rotor

plates swing downward when the plates are unmeshed.

When the condensers, C and D, are mounted upon the dials, all the instruments supported by the panel may be mounted thereon in the positions shown in Figures 1 and 3. The equalizer, V, is attached to the condenser, C, by bolting it to the rotor of this condenser with a 6/32 bolt.

The next step is the preparation of the baseboard, X2. After finishing with wood dye, the instruments may be mounted in their respective places, as shown in the diagrams, care being taken to see that all terminals are exactly in the positions shown.

The Polytrols, N1, N2 and N3, are furnished with mounts and no difficulty will be experienced in mounting them upon the baseboard. The resistors, O1 and O4, are mounted in the double mounting, while O2 and O3 are mounted in the single mountings. In mounting the detector, I, it will be necessary to bend the springs of the mounting outward, as the detector is slightly longer than the resistor which the mounting is designed to fit.

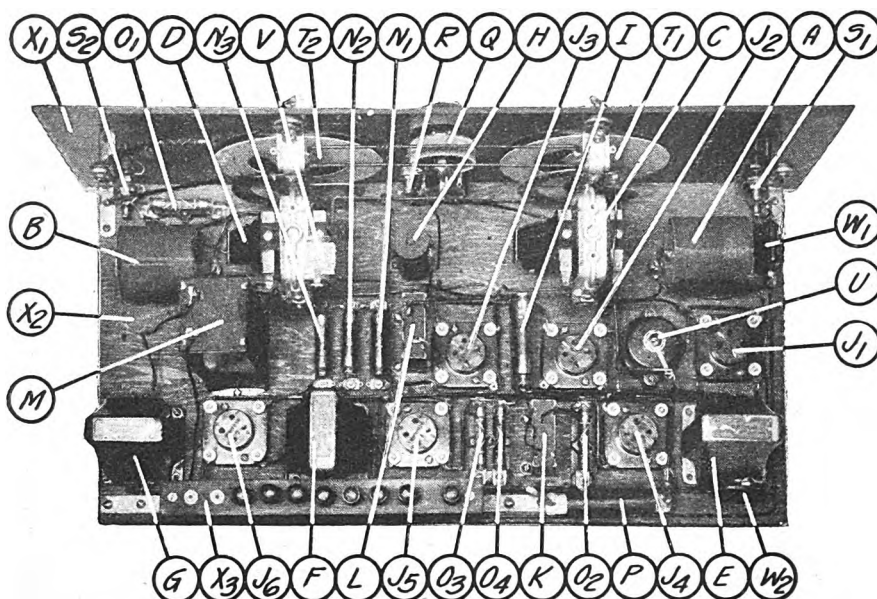
After attaching all the instruments to the baseboard, the panel may be fastened to the base by means of two brackets. The binding-post strip should also be mounted now.

Wiring the Receiver

If the picture wiring diagram in Figure 3 is carefully followed, no trouble will be experienced in wiring the receiver, so that a detailed description of this part of the work is unnecessary.

Any kind of stiff bus wire may be used, but it is advisable to use the spaghetti-covered type, such as Celat-site, as short-circuits are avoided more easily with it.

It is well to begin by connecting up the filament, pilot lamp and ground circuits first. In this connection, it might be well to call attention to the connection between the framework of dial



HOW THE INSTRUMENTS ARE MOUNTED

FIGURE 1: The crystal detector, the heart of the circuit, is shown at I. The other parts are spaced evenly on the baseboard, X2.

T1 and the terminal lug of the pilot light on this same dial; it should be noted that it is the rear lug to which the connection is made.

It should be further noted that the cases of condenser M and transformer E are connected to the ground or the "A" negative (—) lead.

It is important in connecting the detector, I, that the end marked "A" be connected to the "P" terminal of socket J3, and the end marked "G" be connected to the "B" positive (+) terminal of transformer E.

The bottom lead of coil H goes to resistor P, the middle terminal to the rheostat, Q, and the top to the "P" terminal of socket J3.

The long lug on top of the phasatrol is connected to the same point as the

bottom terminal of coil H, that is to resistor P. The terminal marked "P" connects to the "P" post of socket J1, while the terminal marked "PC" is wired to the resistor, R.

As the rest of the wiring is self-evident from the diagram, no further description will be necessary here. After completing the wiring, the resistances, equalizers and detector may be placed in their respective clips.

The Installation of the Set

The construction and wiring of the set being finished, it is now in order to connect the batteries or power-pack and get the receiver ready for operation.

First insert the valves in their proper sockets. The following vacuum valves are recommended for the best results:

In sockets J1, J2 and J3 insert three Ceco type A valves. In sockets S4 and S5 place two Ceco type G valves. In the last stage is placed a Ceco type J-71 power valve.

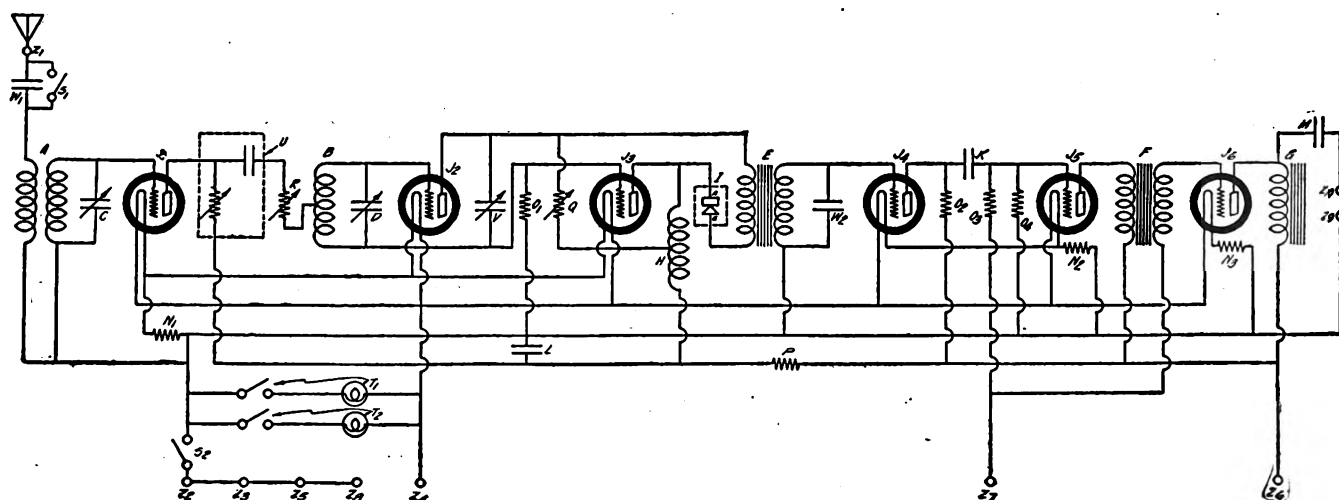
Next connect the "A" battery, being careful to get its polarity right, after which the filament switch may be pulled out to its "on" position, when the filaments in all the valves should light. As a further test, the "A" battery may be disconnected from its proper posts and connected to the "B" battery posts, and the filament switch operated, in which case the filaments should *not* light, if the set is correctly wired. The "A" battery is again connected to its correct place, and the "B" battery connected to its proper binding posts. For best results, a "B" potential of 180 volts should be used, furnished either by a good power-pack or batteries. If 135 to 150 volts is used, it might be well to substitute a 3,000-ohm resistor for the 5,000-ohm one at P, and if the set is operated on 100 volts of "B" battery this resistor may be short-circuited entirely.

The "C" battery should next be connected to its proper binding posts, and its voltage will depend upon the "B" voltage used. When using 180 volts, with a 171 type valve in the last stage, the "C" battery should be one of 40 volts. With 135 volts "B" battery, the "C" voltage should be about 30 volts or less.

When using a Ceco type F valve in the last stage, and 135 volts of "B" battery, the "C" voltage should be 9 volts.

The antenna and ground should now be connected to their respective posts and the speaker connected by pushing its cord tips into pup-jacks Z9 and Z10.

(Continued on page 244)

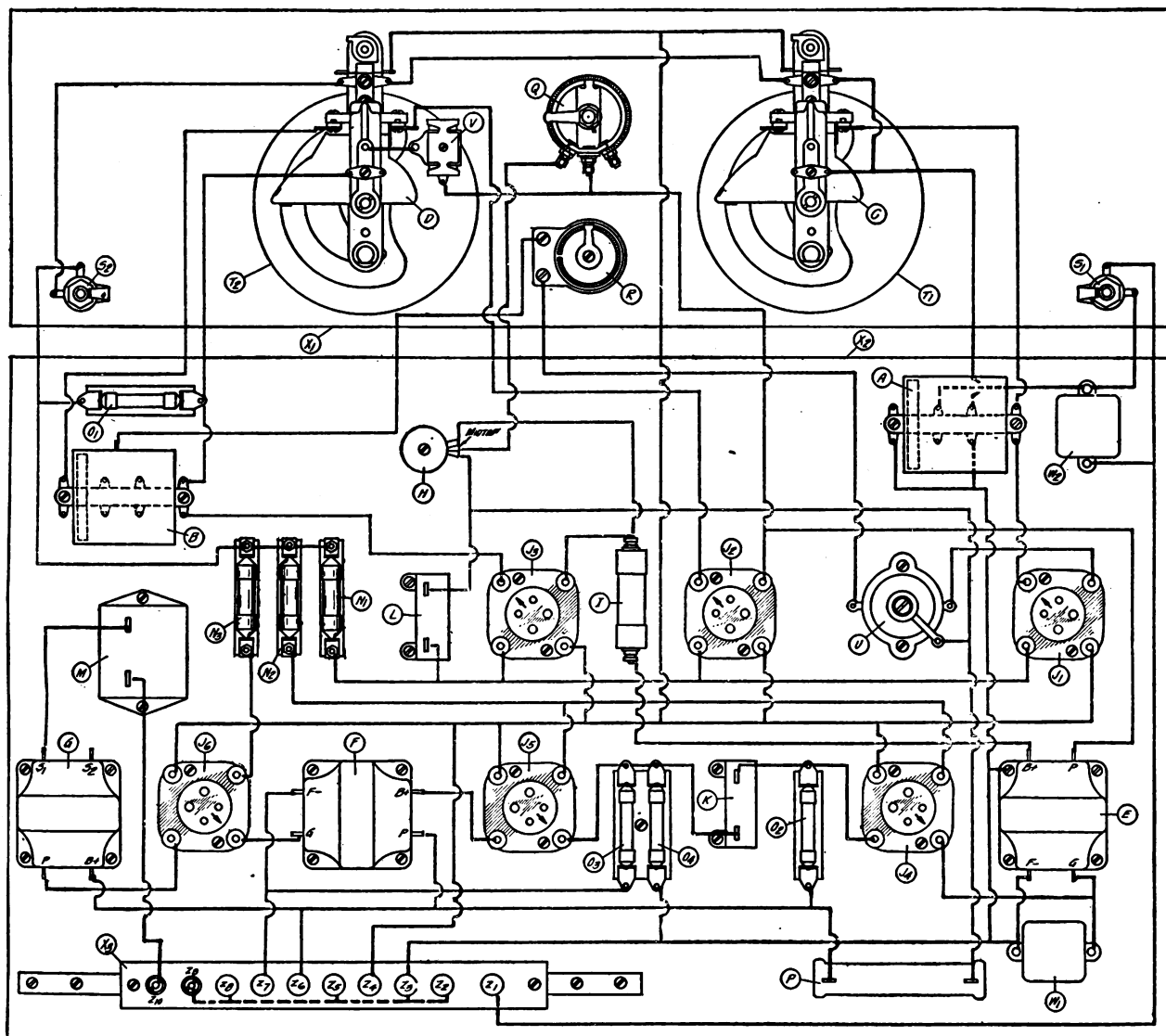


THE CIRCUIT OF THE NEW RECEIVER

FIGURE 2: The high-frequency amplifier at the left works into the crystal detector at I. The low-frequency amplifier at the right combines resistance and transformer coupling.

POPULAR RADIO WORK SHEET

THE GRIFFITH ORTHOPHASE RECEIVER



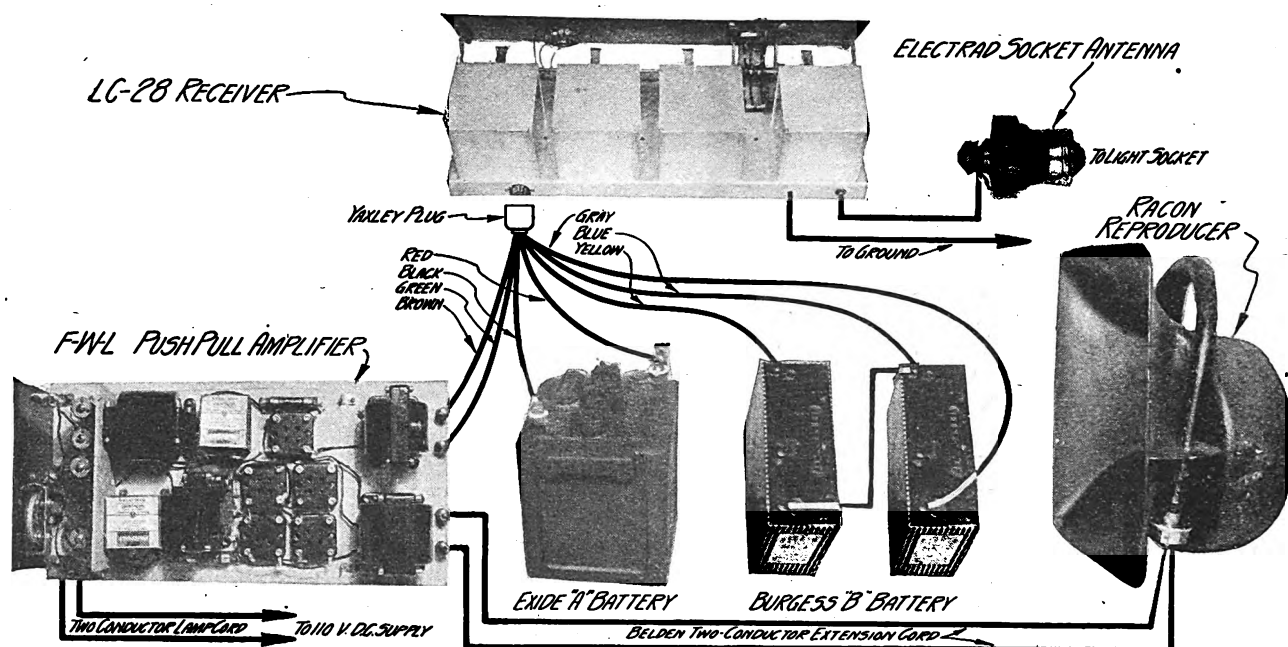
THE WIRING OF THE ORTHOPHASE

FIGURE 3: All the wiring is done above the wooden baseboard, X2, and is shown here on solid red lines. The instruments are outlined in black, in the approximate positions in which they are to be mounted. The positions are not critical, but care should be taken to mount the units, E, F and G, turned in the positions shown.

LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$79.00

- | | | |
|--|--|--|
| A and B—Hammarlund fixed coupling coils, type RF-17; | M—Polymet filter condenser, type B, 4 mfd.; | V—Hammarlund equalizer condenser, type EC; |
| C and D—Hammarlund midline variable condensers, type ML-17, .00035 mfd.; | N1, N2 and N3—Polytrols, type Nos. 7, 5 and 5, respectively; | W1—Polymet moulded condenser, .002 mfd.; |
| E and F—Samson symphonic low-frequency transformers; | O1, O2, O3 and O4—Carborundum resistors, 2 megohms, .1 megohm, .25 megohm and .25 megohm, respectively, equipped with Lynch mountings; | W2—Polymet moulded condenser, .00025 mfd.; |
| G—Samson output impedance, type O; | P—Lynch heavy-duty resistor, 5,000 ohms; | X1—Westinghouse Micarta front panel, 7 by 21 by 3/16 inch; |
| H—Precision tapped choke coil, No. 380; | Q—Electrad variable resistor, 200 ohms; | X2—Wooden baseboard, 10 by 20 by 1/2 inch; |
| I—Carborundum crystal detector, type 30, equipped with Lynch mounting; | R—Electrad Royalty resistor, type H, 25,000 ohms; | X3—Westinghouse Micarta binding-post strip, 1 by 9 by 3/16 inch; |
| J1, J2, J3, J4, J5 and J6—Benjamin Cle-ra-tone sockets, No. 9040; | S1 and S2—Electrad battery switches; | Z1, Z2, Z3, Z4, Z5, Z6, Z7 and Z8—Eby binding posts; |
| K—Polymet Hi-volt filter condenser, type A, .1 mfd.; | T1 and T2—Marco illuminated vernier dials; | Z9 and Z10—Yaxley "pup" jacks; 4 brass brackets; |
| L—Polymet Hi-volt filter condenser, type A, .5 mfd.; | U—Electrad phasatrol; | Celatsite hook-up wire, screws, solder, bolts, nuts, etc. |



HOW TO HOOK UP THE DC AMPLIFIER

FIGURE 1: The amplifier at the left operates entirely from the DC light socket; the "A" and "B" batteries shown above are for the operation of the LC-28 high-frequency pack with which the amplifier is used.

High Quality with Low Voltage from the DC Socket!

A DC Socket Operated Amplifier

Here is a unit that all radio fans living in DC-wired neighborhoods have been long waiting for—a high-power, high-quality amplifier employing four 171-a type power valves in a push-pull stage that operates directly from the 110-volt DC lighting lines.

By WENDELL BUCK

EACH passing year has seen the man with alternating current in his home go merrily on his way towards the achievement of better tone quality. He can use 171 type valves in push-pull arrangement; or he may construct a stage of 210 type valve amplification which, used as the second of two stages, leaves little chance for improving tone and power.

But when it comes to direct current we find the problem a much more baffling one. On 110 volt DC lines, the maximum voltage obtainable through a power unit (after deducting the drop through the system) is between 90 and 100 volts. Now all of us know that 90 volts used on the plates of vacuum valves in the ordinary two-stage, transformer-coupled amplifier fails to give as much power and as fine tone as we like to have.

However, there is another method of securing fine tone and power which ex-

tends the opportunity of operating the power amplifier direct from the 110 volt DC lines without batteries.

The direct-current power amplifier described in this article will interest all radio fans whose home current supply is direct current at 110 to 120 volts. It is a complete two-stage DC light-socket operated unit designed for high quality of reproduction, with power enough to give a real punch and depth to music and speech.

No batteries of any kind are required; "A," "B," and "C" voltages are supplied to the five valves through a simple yet efficient system of four inexpensive resistors.

The circuit combines a stage of transformer-coupled amplification with a second stage of push-pull amplification employing four 171-a power valves. In the second stage, two vacuum valves are used in parallel in each side of the push-pull circuit. This system of di-

viding the power in the push-pull stage provides unusual handling capacity, real volume and power, as well as undistorted output to the speaker.

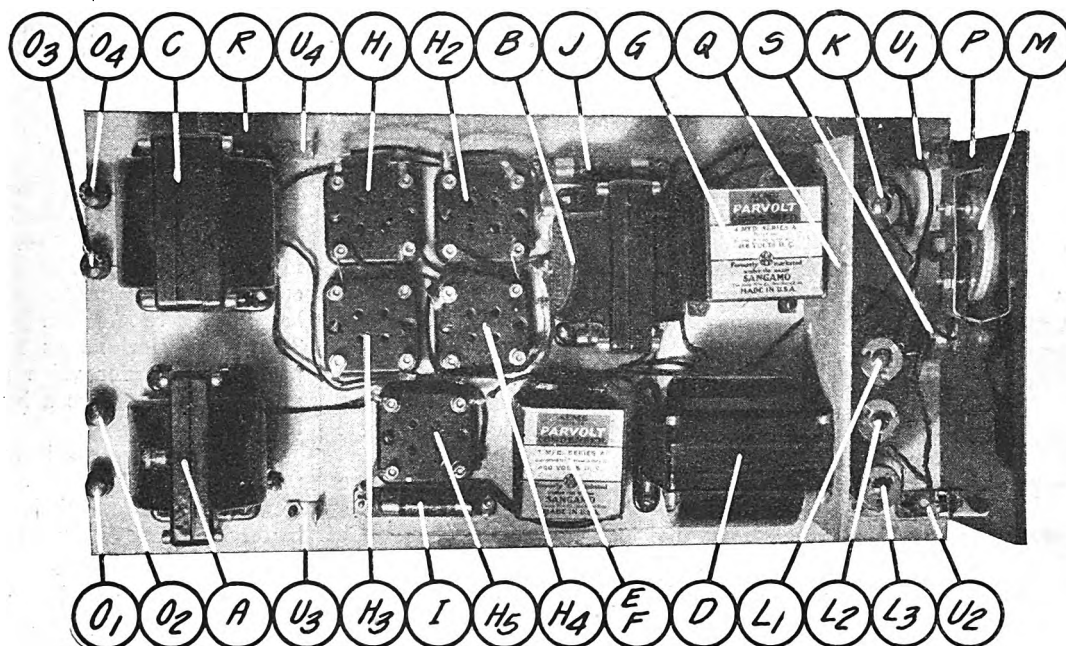
The complete eliminator-power amplifier is a compact, trouble-proof unit that once assembled and tested will give long service without attention of any kind. A perforated metal case is used to house all parts, except the first stage and output transformers.

It should be pointed out that resistor specifications are computed around a fixed filament load of 1.25 amperes, and that these specifications should not be changed. Five valves of the ¼-ampere type are employed for amplification, and with this knowledge an exact combination of resistor values is offered to handle properly this arrangement of valves. Voltage and current of the right value are delivered to each valve when all five are in their sockets. Should

(Continued on page 256)

POPULAR RADIO WORK SHEET

THE FWL DC PUSH-PULL AMPLIFIER



HOW THE UNIT LOOKS FROM ABOVE

FIGURE 2: The unit is shown with the perforated metal cover removed, to reveal the mounting positions of the various parts.

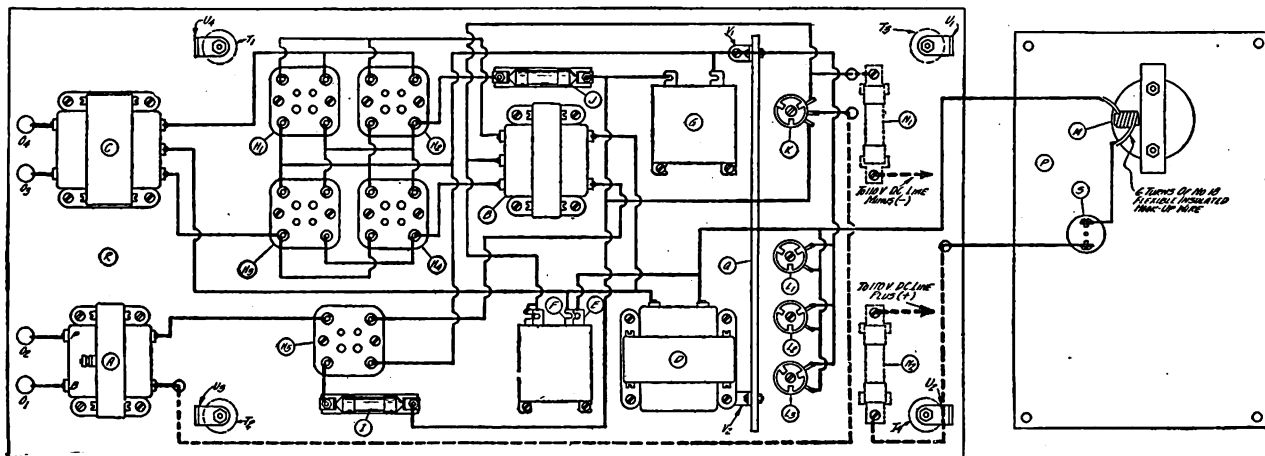
LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$76.00

A—Ferranti low-frequency transformer, type AF-3;
 B—Ferranti input push-pull transformer, type AF-3C;
 C—Ferranti output push-pull transformer, type OP-8(C);
 D—Ferranti choke, type B-1;
 E—Acme Parvult condenser, 1 mfd., Series A, for 400 volts;
 F—Acme Parvult condenser, 2 mfd., Series A, for 400 volts;
 G—Acme Parvult condenser, 4 mfd., Series A, for 400 volts;
 H1, H2, H3, H4 and H5—Frost sockets, No. 530;

I—Amperite, type 1-A;
 J—Amperite, type 4-A;
 K—Ward-Leonard mid-tapped A-tube resistor, 8 ohms;
 L1, L2 and L3—Ward-Leonard B-tube resistors, 250 ohms;
 M—Ward-Leonard battery-charging meter, type BT;
 N1 and N2—Electric fuses, 10 amperes, equipped with fuse clips;
 O1, O2, O3 and O4—Eby binding posts;
 P—Formica panel, 7 by 4½ by 3/16 inch;

Q—Transite baffle board, 6¾ by 4½ by ¼ inch;
 R—Transite baseboard, 15 by 8 by ½ inch;
 S—Cutler-Hammer toggle switch;
 T1, T2, T3 and T4—Round wooden feet;
 U1, U2, U3 and U4—Brass angle brackets, 1 by 1 by ½ inch;
 V1 and V2—Brass angle brackets, ½ by ½ by ¾ inch;
 W—Ward-Leonard perforated metal cover, 11½ by 7 by 4½ inches;



HOW TO WIRE THE UNIT

FIGURE 3: All the wiring above the transite baseboard, R, is indicated here in solid RED lines. Dotted RED lines indicate wires that run under the baseboard.

The ABC of Filament Control

QModern receiver design demands simplicity in operation. By the use of the convenient data in this article any fan can eliminate one or more hand-operated controls on his receiver, and insure long life and efficiency for his vacuum valves.

THERE seems to be a considerable doubt in the minds of some set builders regarding the proper use of valve filament control resistances, such as Amperites, Equalizers and Polytrols.

These resistances may be used with all types of vacuum valves in any receiver, to provide each valve with its proper operating current. Or, where the control of the filament current must be variable, as in the case of many

high-frequency amplifiers in which the volume is controlled by means of a filament rheostat, filament controls may be also successfully used in conjunction with a rheostat to prevent excessive current from flowing in the filaments even when the rheostat is turned full "on."

The only exception to this practice is in the case of receivers which operate their valves from dry cells. There

the voltage variation is too great to permit the practical application of filament controls. When the batteries are new, for instance, their total voltage is in excess of $1\frac{1}{2}$ volts each, but at the end of their useful life their voltage has dropped to less than one volt each. The only logical means for providing proper current for valve filaments in such a case is to use a hand-operated rheostat.

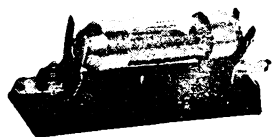
In the average receiver which employs 5-volt valves or 3-volt valves, and is to be operated from a storage battery, it is advisable to use a separate filament control for each individual valve, because it is only in this way that one can insure the proper current for all valves at all times. If a single control is used to regulate the current for two or more valves, it is necessary to turn "off" all filaments when changing valves or in switching valves around, otherwise when one of the group of valves controlled by a single control is removed from its socket the current through the balance of the filaments is immediately increased, with the result that these filaments may be severely overloaded. But where all valves are controlled by individual controls, the removal of one or more valves from their sockets has absolutely no effect on the others, and it is therefore not necessary to turn "off" the filament current before removing one or more of the valves.

In some cases space does not permit the use of a separate filament control to each valve, or perhaps it is necessary to keep the cost of construction down to an absolute minimum. In that case it is possible to operate from two to four valves through a single control. These valves may be of different types or they may all be of the same type. The only requirement is that the controls used must be the proper type to supply the total current required by the group of valves used.

Take a resistance-coupled amplifier, for instance, with three stages in which two .25-ampere valves and one .5-ampere valve are used. The total current required by these three valves is 1 ampere, and this may be obtained through the use of a No. 1 Amperite, a No. 1 Equalizer or a No. 3 Polytrol. Or, again, there may be an amplifier

(Continued on page 243)

FILAMENT CONTROL CHART



TYPE OF VALVE	FILAMENT CURRENT IN AMPERES	BATTERY VOLTAGE	TYPE OF FILAMENT CONTROL NECESSARY
201-a	.25	6	Amperite No. 1-A Polytrol No. 1 Equalizer No. 4
200-a	.25	6	Amperite No. 1-A Polytrol No. 1 Equalizer No. 4/3
112	.5	6	Amperite No. 112 Polytrol No. 5 Equalizer No. 2
171	.5	6	Amperite No. 112 Polytrol No. 5 Equalizer No. 2
199	.06	4 or 4.5	Amperite No. 4V-199 Polytrol No. 2 Equalizer No. 50
120	.125	4 or 4.5	Amperite No. 120 Polytrol No. 6 Equalizer No. 25
WD-11	.25	1.5	Amperite No. D-11 Polytrol No. 4
Any 1 Amp. 5 V. Valve	1.0	6	Amperite No. 1 Polytrol No. 3 Equalizer No. 1
Any .75 Amp. 5 V. Valve	.75	6	Amperite No. 3-A Polytrol No. 7 Equalizer No. 4/3



STILL BETTER—the HI-Q WITH SCREENED-GRID VALVES

Fans everywhere are getting ready to make use of the marvelous possibilities of the new screened-grid valves, and the originators of the Hi-Q "Six" have kept up with the times by designing a new model of the Hi-Q for use with the screened-grid valves. The changes necessary for installing screened-grid valve amplification in the standard receiver are so few, and the results so satisfactory, that no radio fan should miss the change-over details given here.

By LESLIE BILES

MANY readers of POPULAR RADIO who have followed the series of articles on the Hi-Q "Six" receiver have written in asking whether the new screened-grid valves may be employed in the set. This development has been the subject of considerable experiment, both in the POPULAR RADIO Laboratory and in the laboratories that have developed this remarkable receiver. As the result of these experiments, a new model of the set employing two screened-grid type valves has been evolved and will be described in this article.

In the new model of the set the two screened-grid valves are utilized in the first two stages of high-frequency am-

plification. These two stages are tuned by the left-hand dial. The right-hand portion of the set, comprising a third stage of high-frequency amplification and a detector stage, are operated with standard vacuum valves, as in the earlier models.

The first stage of the set has been left substantially as before except that an equalizing condenser, CC1, in Figure 1, is added in parallel to the regular tuning condenser, C1. The filament resistor in this stage, R8, has also been changed to 10 ohms to take care of the different filament characteristics of the new valve. The connection from the high end of the variable condenser and coil has also been shifted off the grid

terminal of the socket and replaced by a clip that will connect to the top terminal of the new type valve. Also, as may be noted in Figures 1 and 2, the grid resistors in the first and second stages are eliminated. The screened-grid connections are made to the regular grid terminals of the sockets.

In the second stage these same changes are made; in addition the primary of the tuning coil has been left out of the circuit. A connection is made through a .0001 mfd. blocking condenser to the top end of the secondary coil in this stage. Also a volume control has been inserted on the panel, consisting of a combination switch and variable high resistance shunted across the choke

POPULAR RADIO WORK SHEET

THE HI-Q "SIX" WITH SCREENED-GRID VALVES

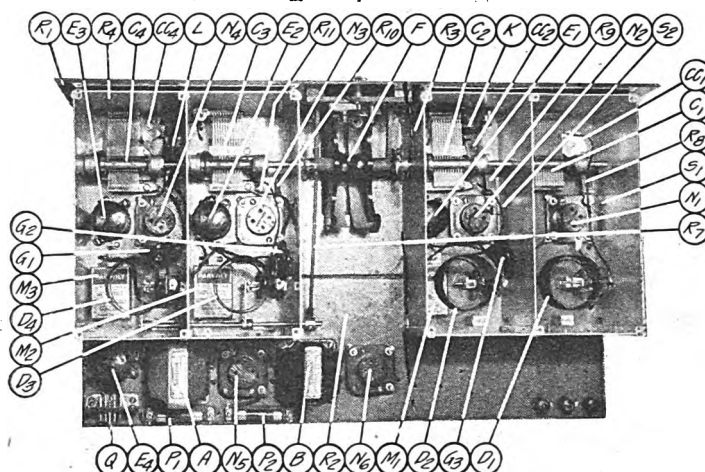
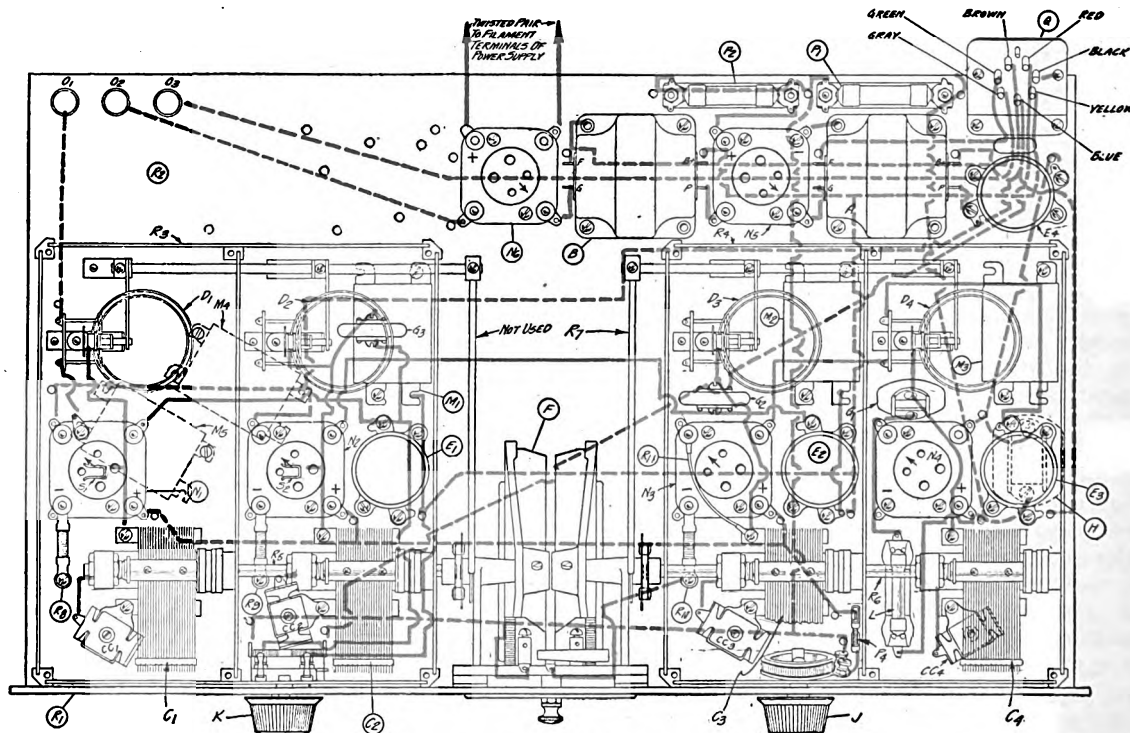


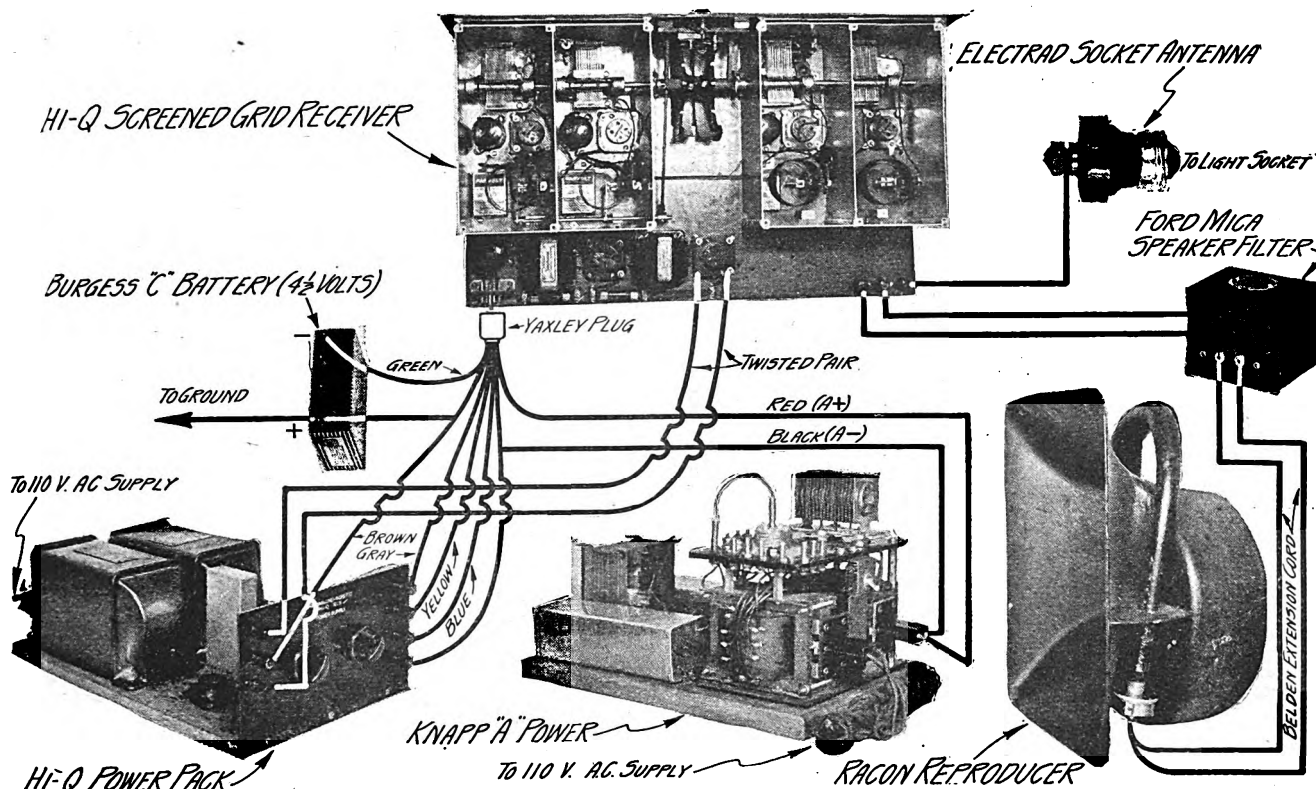
FIGURE 1: THE PANEL LAYOUT

LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$102.00

- | | | |
|--|--|--|
| A—Samson symphonic transformer; | J—Carter Imp rheostat, 6 ohms, type 1-R-6; | R—Hi-Q "Six" foundation unit, containing: |
| B—Samson transformer, type HW-A-3; | K—Electrad tonotrol and filament switch, 10,000 ohms, type WS; | R1—Drilled Micarta panel, 7 inches by 21 inches by 1/8 inch; |
| C1 to C4—Hammarlund midline variable condensers, .0005 mfd.; | L—Durham metalized resistor, 2 meg-ohms; | R2—Drilled metal chassis; |
| CC1 to CC4—Hammarlund equalizing condensers; | M1 to M5—Acme Parvolt by-pass condensers; .5 mfd., Series A; | R3 and R4—Two-stage aluminum box shields; |
| D1 to D4—Hammarlund auto-couple coils, type HQ-64; | N1 to N6—Benjamin Cle-ra-tone sockets, No. 9040; | R5 and R6—Brass extension shafts for variable condensers; |
| E1 to E4—Hammarlund chokes, type RFC-85; | O1, O2 and O3—Eby engraved binding posts, marked <i>Speaker</i> +, <i>Speaker</i> — and <i>Antenna</i> , respectively; | R7—One cam operating assembly; |
| F—Hammarlund illuminated drum dial; | P1 and P2—Amperites, No. 1-A; | R8 and R9—Grid biasing resistors, 10 ohms; |
| G1—Sangamo mica fixed condenser, .00025 mfd.; | P4—Carter fixed resistor, 1 ohm; | R10—Grid biasing resistor, 4 ohms; |
| G2 and G3—Sangamo mica fixed condensers, .0001 mfd.; | Q—Yaxley cable connector and cable No. 660; | R11—Grid suppressor (red); |
| H—Sangamo mica fixed condenser, .001 mfd.; | | R12—Grid-leak mounting block; |
| I—Sangamo grid-leak clips; | | R13—Bakelite binding-post strip; |
| | | Clips for control grid; |
| | | Wire, screws, solder, etc. |





HOW TO GET THE BEST FROM THE SCREENED-GRID HI-Q

FIGURE 3: The operating hook-up shown above gives the utmost in efficiency and quality reproduction with the Hi-Q "Six" as remodeled for the use of screened-grid valves. It operates entirely from the AC lighting lines, with the exception of the small "C" battery shown at the left. The Hi-Q power-pack shown is the standard pack designed for use with the original model of the Hi-Q "Six."

coil. This is a combination instrument that also acts as a filament switch when turned all the way "off." A by-pass condenser has been added between the shielding grids and the filament circuit.

The only change in the third stage of high-frequency amplification is that the primary coil has been left and a connection has been made between the plate circuit and the high end of the secondary coil and variable condenser through a .0001 mfd. blocking condenser. Of course, the four added equalizing condensers, CC1, CC2, CC3 and CC4, are to allow for balancing up the four stages of tuning. It will be noted that these changes rearrange the circuit so that conductive coupling is used in the screened-grid valve stages.

These changes are shown clearly in Figure 2. The two .5 mfd. by-pass condensers, M4 and M5, mounted underneath the chassis are shown in their relative positions in dotted black lines, in the picture wiring diagram in Figure 2.

All that is necessary is to build the set along the general lines prescribed in the original constructional article in the November, 1927, issue of POPULAR RADIO, with the additions mentioned above and following the exact connections give in the picture wiring diagram in Figure 2. The set itself may be entirely wired with flexible Celatsite

and should be carefully checked before being placed in operation.

Operating Data for the Hi-Q Receiver Using Screened-Grid Valves.

First of all, the set, upon completion, should be placed in its Corbett cabinet, as shown in the illustration at the beginning of this article. Then it should be connected up by means of the Yaxley cable to the Hi-Q power-pack, as shown in the photo-diagram in Figure 3. This diagram gives the connections for the light-socket antenna, the ground, the "C" battery, the output filter and the Racon exponential reproducer. The home-built Knapp "A" power unit is also shown correctly connected, to furnish complete filament current for all the vacuum valves.

When these external connections have been made, insert two CX-322 type screened-grid valves in sockets N1 and N2, fastening the clips to the electrodes on top of the valves. Then insert a Zetka ZRF type valve in socket N3 and a Zetka ZD type detector valve in socket N4. Insert a standard CX-301-a type valve in socket N5 and a CX-371 type power valve in socket N6.

The set is now ready for operation and the combination switch volume control, K, should be turned "on" and a station should be tuned in. Then the

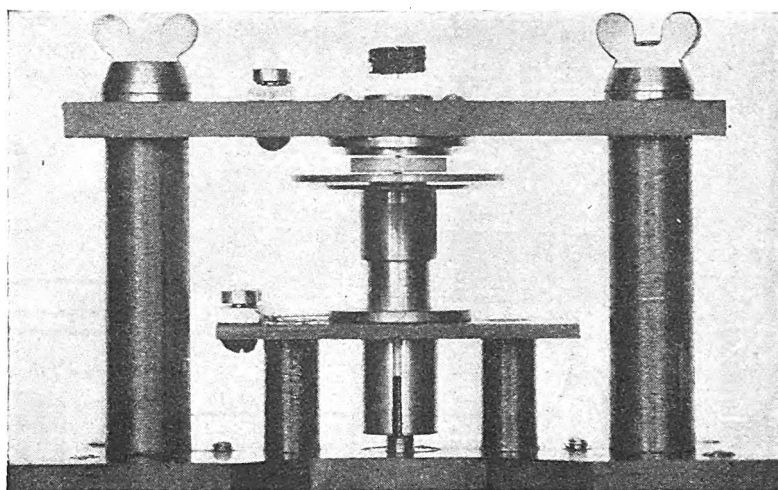
equalizing condensers, CC1, CC2, CC3 and CC4, should be lined up, by turning the small screws with an insulated screw driver until the signals come in the loudest. At this setting the tuning stages will be lined up in synchronism.

It will be noted that the cam assembly on the first two tuning stages has been omitted, as it is not used when the screened-grid valves are utilized. The primary on the second stage is left out of the circuit and the first primary is to be fastened permanently by a string so that it is lightly coupled. Other operating hints on the receiver, such as the adjustment of the Hi-Q power-pack, will be found in the article in the January, 1928, issue of POPULAR RADIO on the Hi-Q "Six" power supply.

With this new model of the receiver much higher over-all amplification is obtained and the sensitivity of the set accordingly greatly increased.

Distant signals that might be received weekly with the original model come in with full local volume by the use of these new valves, and signals that could not be heard with a standard set are made clearly audible.

When the set has been finally balanced the two shield tops should be attached by means of six screws and the set will be ready to function satisfactorily for an indefinite period.



A 3-INCH RADIO MOTOR

FIGURE 1: The moving element of the motor may be seen in the center of the picture, mounted between the upper and lower insulated frames. The two terminals by which the motor is connected into a high-frequency circuit may be seen at the left center of the crosspieces of these frames. This picture is approximately full scale.

BROADCAST ENERGY OPERATES THE RADIO MOTOR

A motor that may be run on the received signal energy of a broadcasting station is the novel invention of the German physicist, Dr. Alexander Meissner.

By HENRY SIMON

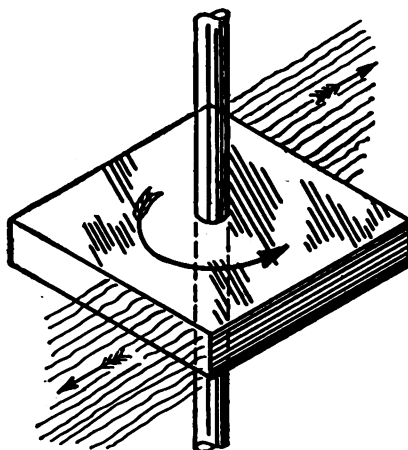
German Correspondent of POPULAR RADIO

AN electro-motor which can be connected in an ordinary radio circuit and made to operate by the broadcast energy of a transmitting station, has been invented by Dr. Alexander Meissner, an eminent radio physicist associated with the Telefunken Gesellschaft of Berlin. Worthy of particular note in this new radio device is the extraordinary simplicity, both of the principle employed and of the motor itself. A view of the invention, which, though an unquestionable success in so far as its working is concerned, has not yet borne practical results, is shown in Figure 1.

The motor consists essentially of a small quartz plate mounted on a fine spindle between two electrodes. The upper electrode is fixed in the insulating bar which forms the top member of the frame, while the lower electrode is rendered capable of fine up-and-down adjustment by being mounted on a movable column carried in the inner frame.

Any high-frequency current will operate the motor, provided the current is of a frequency corresponding to the period of vibration of the quartz plate, which is about 190 kilocycles. When the current admitted to the electrodes

coincides with this frequency, the quartz plate starts to vibrate, and this vibration sets up rapid air currents on opposite sides of the plate. Now if these disturbances issued evenly over the entire area of the opposite sides, they would counteract each other, and



HOW AIR CURRENTS ARE CREATED BY THE CRYSTAL

FIGURE 2: This diagram shows how the air currents generated by the vibrating quartz crystal are stronger at the corners of the crystal, so that a torsional force about the spindle is created.

nothing further would happen. As a matter of fact, however, the air currents are strongest near the corners of the square, as indicated in the diagram in Fig. 2, so that a torsional effect is created which causes the quartz plate to spin by the reaction of the air currents upon the surrounding atmosphere. An idea of what happens can be gained by comparing the action of these currents with that of the old water reaction wheel, which is driven by the reaction of the tangent streams issuing from oppositely-directed outlets.

The disc shown on the top of the spindle in Figure 1 serves merely as a convenient means of verifying the revolution of the motor. In a more powerful motor of the same type, assuming one could be built, it would be replaced by a regular pulley or other means of utilizing the motion. At present, the force created in the little model is sufficient only to cause the rotation of the motor, though some very delicate mechanism might, of course, also be driven by it.

The motor plate is about $\frac{5}{8}$ -inch square, and the height of the entire arrangement is approximately 3 inches.

AN ALL-ELECTRIC LC-27

The thousands who are still getting big results with their LC-27 receivers will want to try this new jiffy method of obtaining their filament current from the AC lighting lines. The cost of the new apparatus is small, the change-over is the simple matter of slipping adaptors and harness into the old sockets, and if a "B" power-pack is used for the plate supply, the results will put the LC-27 on a par with the newest of 1928 socket-operated receivers.

By LAURENCE M. COCKADAY

RADIO progress has now brought us to the point where it is an extraordinarily simple operation to convert any battery-operated receiver into a completely light-socket operated unit. With the development of AC valves, socket operation involves nothing more than an "A" power transformer and a "B" power-pack, together with suitable balancing devices necessary when AC current is introduced into the filament circuits of high-frequency amplifiers.

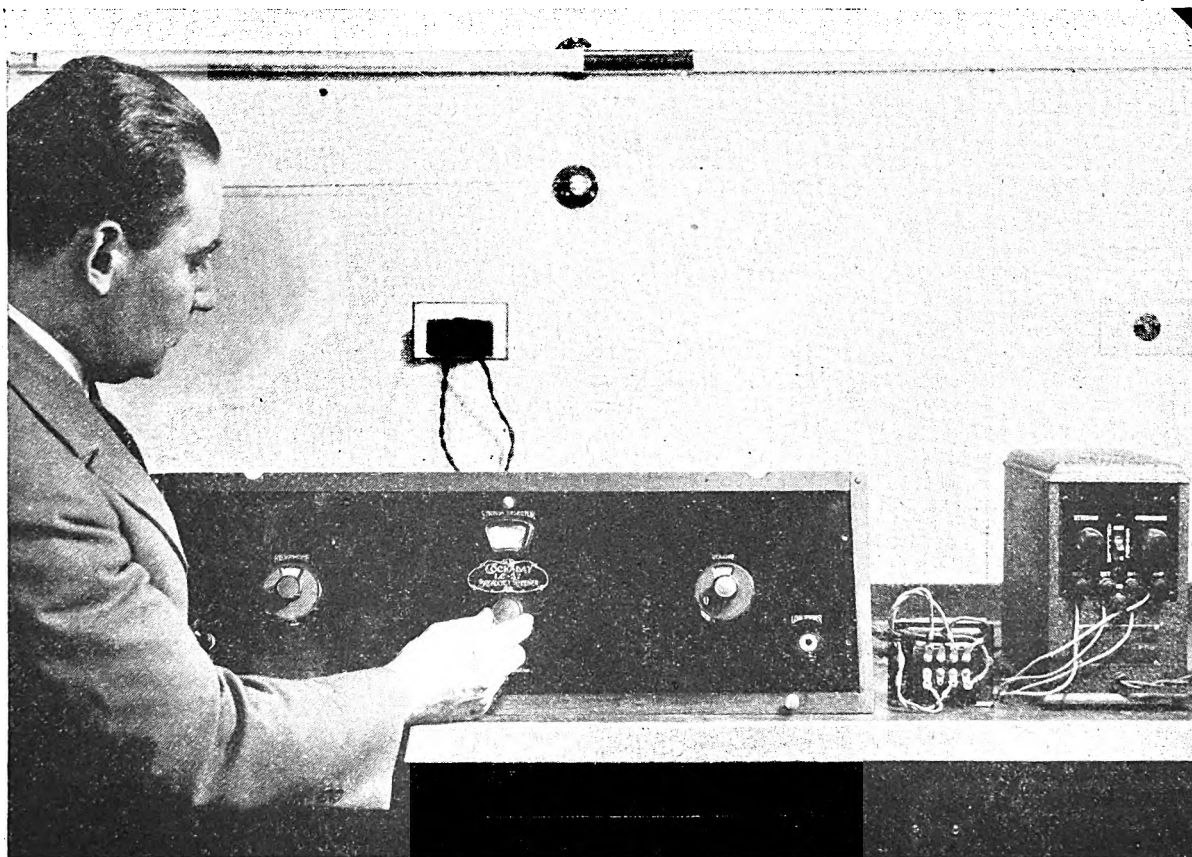
The problem of "B" power-packs was solved long before the introduction of AC valves, and there are now on the market suitable "B" power units for

every kind of receiver, making possible complete socket operation.

The introduction of AC adaptors, such as the Na-Ald, Eby or Marathon, has made the change to light-socket operation a matter of only a few minutes. These adaptors are units which have prongs underneath for insertion in the socket of a battery-operated receiver and a socket above for receiving the prongs of an AC valve. In conjunction with the new AC valves and a small heater transformer, the adaptors furnish a very satisfactory method of "A" current supply from the lighting lines, without the use of any batteries.

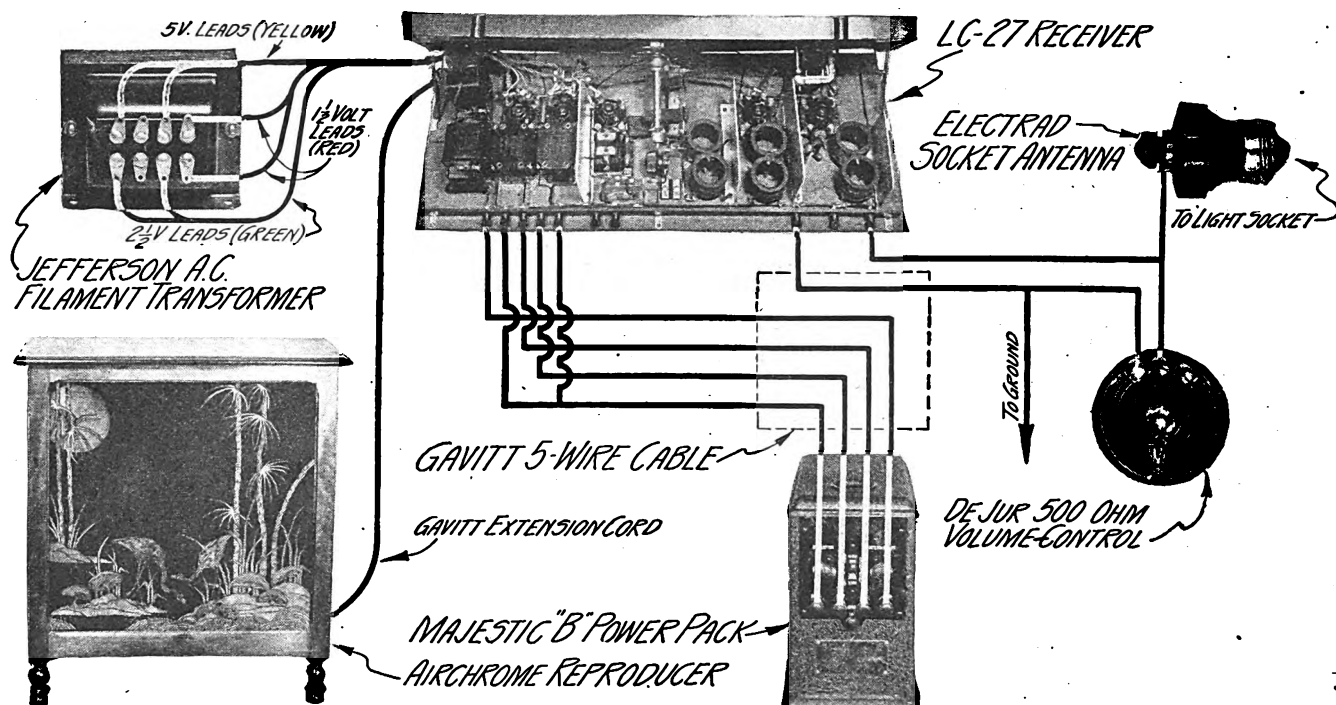
Furthermore, "C" bias is provided by a voltage drop across a resistance in the adaptors.

There are three general types of adaptors. In this particular instance Na-Ald connectorals are used. In all of these the plate and grid terminals of the valves are connected through the connectorals to the plate and grid terminals of the sockets in the set. Also, the filament and heater terminals of the valves are brought out to external binding posts on the connectorals in all cases. In the No. 926 (red) connectorals, the filament prongs are left unconnected. In the No. 927 UY (green)



1928 OPERATION FOR THE LC-27

By means of the new adaptors and the small transformer shown just to the right of the set, the lighting lines can be used for the filament supply for the LC-27. With the "B" power-pack at the right supplying the plate voltages, the LC-27 is made a completely socket-operated receiver.



THE COMPLETE AC OPERATING HOOK-UP

FIGURE 1: The socket leads of the filament transformer and the "B" power-pack may be connected together and plugged into the AC lighting lines. The other connections between the receiver, power units, reproducer and socket antenna which may be used are shown clearly in heavy black lines.

connectorald the cathode terminal of the valve is connected through the connectorald to one of the filament terminals of the receiver socket.

In the No. 924 G. T. (red) and the No. 926 G. T. (orange) connectoralds both filament terminals of the receiver socket are connected through the connectorald to an external binding post between the other two external posts.

The Na-Ald RY-500 resistor really consists of two resistance windings; one is a center tap filament resistance which is connected across the external filament binding posts, and the other is a 500-ohm biasing resistance which is connected between the center tap of the

filament resistance and the middle external binding post. These connections are automatically made when the resistor is tightened down on the three binding posts provided. The Na-Ald RY-1000 resistor is similar, but with a 1,000-ohm biasing resistance.

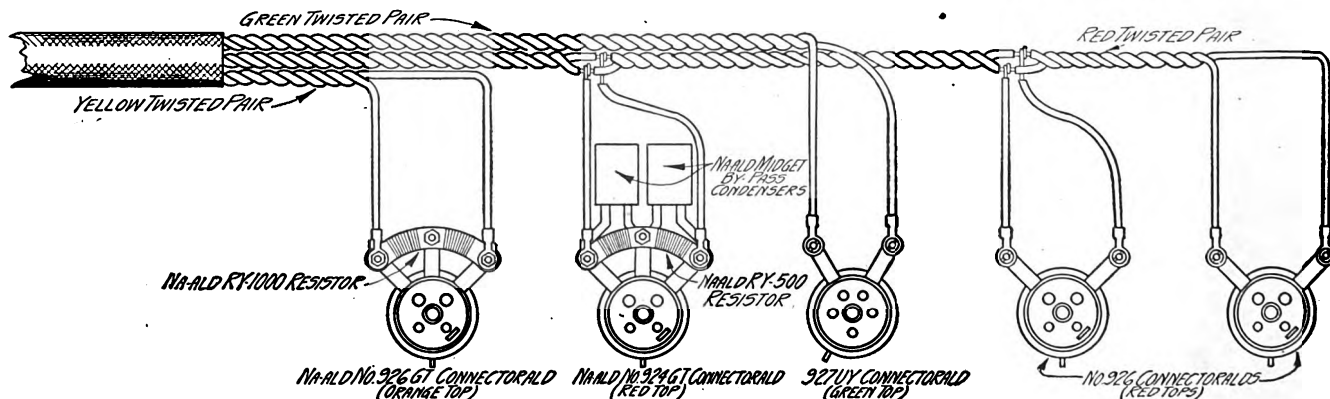
How to Wire the LC-27 Receiver for Socket Power Operation

In addition to a good "B" power-pack, such as the Majestic, the complete apparatus for the electrification of the LC-27 receiver consists of a Jefferson AC filament transformer, the Na-Ald AC connectoralds, center-tapped filament resistances, biasing resistances,

by-passing condensers and a connecting harness.

Refer to Figure 2 for the connections to the Na-Ald connectorald system. Connect the red pair of wires of the harness to the two outside terminals of connectorald No. 924 GT. Using the most suitable red cable lengths, connect these last two terminals to those of each of the No. 926 connectoralds in turn. Then connect the Na-Ald RY-500 resistor to the three terminals of the No. 924 GT connectorald. Also connect two Na-Ald Midget by-pass condensers as shown. Following this, connect the yellow twisted pair of wires to the two

(Continued on page 265)



HOW THE ADAPTORS ARE WIRED

FIGURE 2: The connectoralds shown above are, from right to left, for the two high-frequency valve sockets, the detector socket, and the two low-frequency valve sockets. Carefully follow the directions given in this diagram for cabling the leads.

"I USED TO GIVE RADIO INFORMATION AWAY—NOW I SELL IT"

The Story of a Young Man Who Established a Reputation in Radio and Cashed In On It

By CHARLES A. KENNEDY

I CAN start this little radio story of mine by saying that no one knows how much he can make out of radio servicing and construction until he actually launches into it. For a long time I speculated as to the possibilities of this kind of occupation, but I had no idea of how much I could make until I dug right in and worked at my own business. It's the actual starting that counts.

New Albany, Indiana, where I live, is a city of 30,000 people, and, like a great many other American cities, its residents appreciate quick, intelligent radio service. This kind of service is difficult to get in a town of this size, for there are few men in it who have specialized in this kind of work, or who have had anything but a very superficial preparation. The dealers' service in New Albany is, in general, very bad, due to a lack of training on the part of repair men and service men. I fully realized this before I launched my little enterprise. At the same time, I saw the rare opportunity of construct-

"I am still a radio fan, but now I get paid for work that I enjoy and for work that I used to do for nothing. Two years ago I gave my radio information away—now I get paid well for it. There is a market for service, sets, and radio advice in every neighborhood in the United States, and I am surprised that more radio fans do not capitalize their technical knowledge."

CHARLES A. KENNEDY.

ing standard circuits, and of realizing a substantial profit on the sale of custom-made receivers.

I think that many men are deterred from entering this kind of work simply because they feel that a large investment is necessary. This is by no means

true. A very few simple testing instruments and a very modest supply of tools are all that is needed. I do not believe my investment in tools and equipment runs over \$100, and I started on much less than this. I should say that a very good start can be made on a capital of \$50 or even less, depending on the ingenuity and resourcefulness of the man.

Two years ago I was making \$35 a week. Now I am averaging \$75 and I have on my list many customers for whom I do work regularly. It is important to build up this list of customers, because it tends to stabilize one's income. In certain instances, I make periodic calls with regular service fees. In the case of the better class of customers, it is very easy to make some kind of an agreement on a weekly or monthly basis, as a sort of "consulting radio physician."

At the present time I am regularly employed as a service man in a large radio store in Louisville, which is but a
(Continued on page 239)



THE RADIO "PHYSICIAN" AT WORK

The most satisfactory arrangement that the professional service man can make, both for himself and his clients, is a regular servicing of sets on a weekly or monthly basis. This insures the proper care of the set and the prevention of any serious breakdown, and also gives the service man a steady, dependable income.

USE A "NEEDLE SCRATCH FILTER" FOR *Improving* the Phonograph Pick-up

By MORRIS M. SILVER

THE new electrical pick-up is capable of reproducing, in an electrical sense, a much truer copy of the original sound than is possible with the old style of mechanical reproducer consisting of a vibrating diaphragm attached to a horn.

Of course, the electrical pick-up has other allies that help it to do its work. One of these is the low-frequency amplifier, exactly similar to that used for radio, and the other is a high-quality reproducer, whether it be a cone, an exponential horn, or one of the balanced-tension type.

One of the difficulties of phonograph reproduction, that has bothered the engineer, is the problem of the mechanical scratch of the needle as it passes along in the vibrating troughs in the record. This factor, of course, is just as troublesome in a mechanical phonograph as in the electrical type. A number of mechanical means have been developed to try to eliminate the scratch, some of them partially successful.

A careful study of the frequencies of these scratch noises has brought to light the fact that these frequencies are high enough in the musical scale not to be in actual competition with the necessary musical frequencies used in reproduction.

An ingenious device consisting of a tuned filter, with choke coils and condensers mounted in a small metal box, has recently been developed to deal with this trouble. This device, known as a scratch filter, may be connected in the line from the electrical pick-up and its purpose is to pass through it, to the amplifier, all of the musical frequencies necessary for good broadcast or phonograph reproduction, but to hold back and prevent the frequencies that make the objectionable scratch noise on the phonograph from entering the amplifier at all.

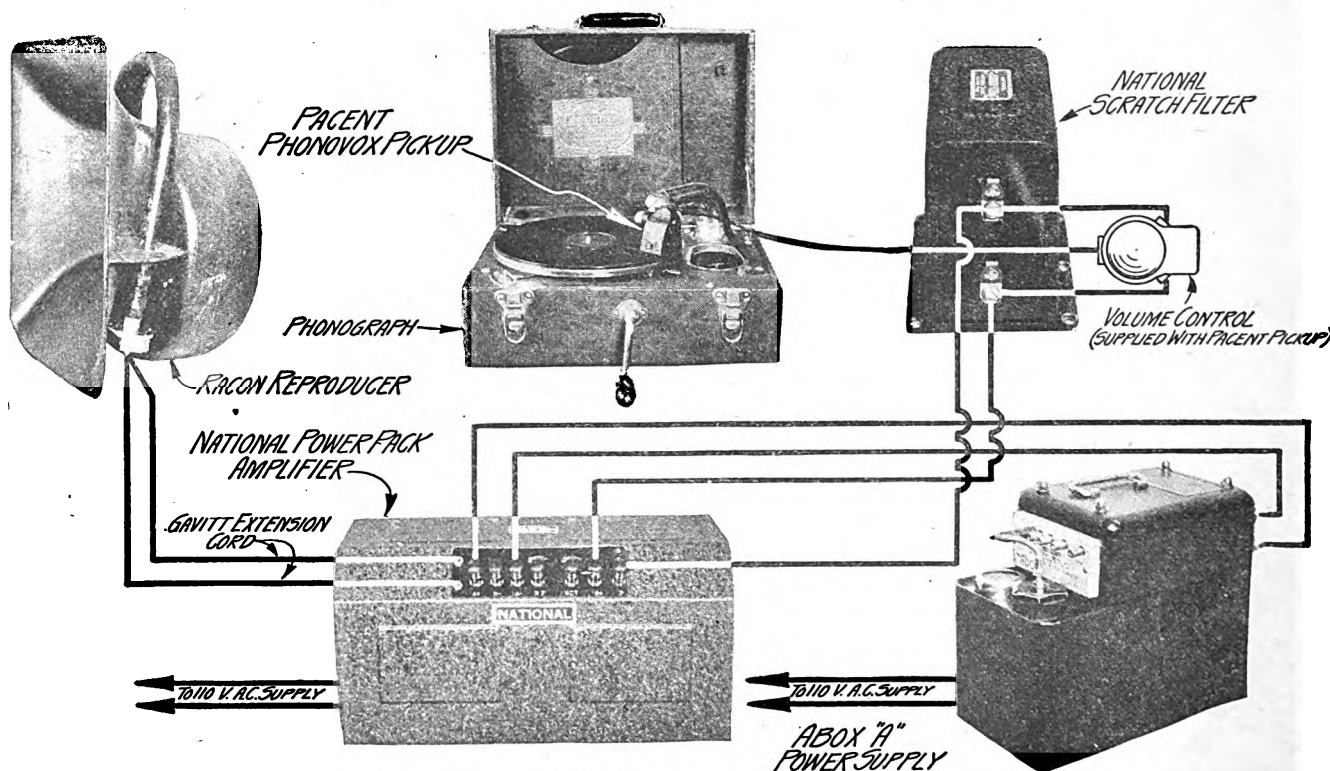
One of these devices installed will add much to the reality of reproduction of any phonograph installation that is operated electrically.

In the photo-diagram in Figure 1 is shown, in the upper right-hand corner, one of these scratch-filters connected in circuit between the electrical pick-up and the input to the amplifier, which is, in this case, the National resistance-coupled power amplifier. This amplifier works directly from the 110-volt AC lighting lines for its "B" and "C" power. Its "A" power may be obtained through an "A" power-pack, as shown in the illustration.

An exponential horn, used in connection with this apparatus, will further tend to enhance the realistic qualities of reproduction that the combination is capable of.

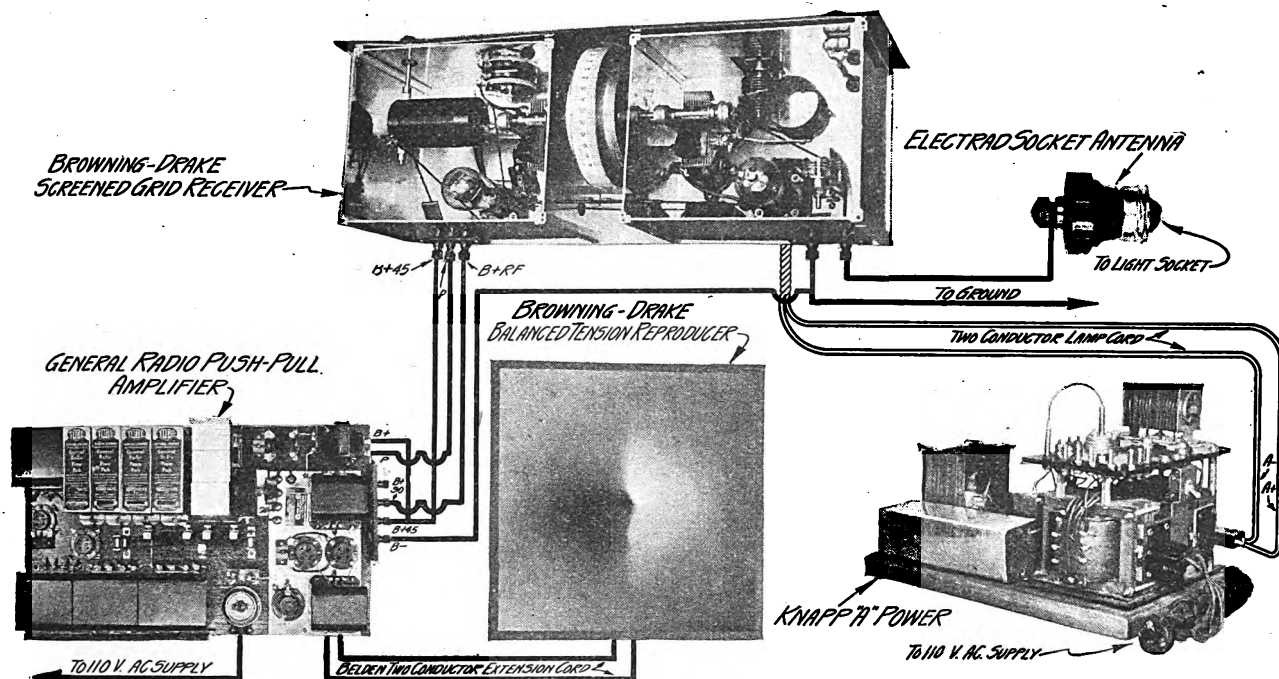
In this illustration a small portable phonograph is shown. However, it may be any type of existing phonograph cabinet that has a workable turntable.

The combination illustrated will reproduce the electrically cut records with a vitality and realism that is surprising. Anyone can make the installation. Try it on your old phonograph.



A COMBINATION THAT ELIMINATES THE NEEDLE SCRATCH

FIGURE 1: The scratch filter at the upper right is designed to filter out the frequencies within which most of the needle scratch noises lie, and pass on to the amplifier only the frequencies of voice and musical reproduction. This combination has the further advantage of complete operation from the AC lighting lines.



HOW TO INSTALL THE NEW BROWNING-DRAKE

FIGURE 1: The installation of screened-grid valve amplification in the Browning-Drake tuner requires little change in the operating hook-up, as this diagram shows. All the necessary connections to the low-frequency amplifier, "A" power, reproducer, ground and antenna are clearly shown in BLACK lines.

Screened-Grid Valves "Pep Up" the Browning-Drake

The design of the Browning-Drake receiver is so simple that the installation of screened-grid valve amplification can be easily done in a few minutes by any fan. The characteristics of the new valve have been carefully studied and the circuit of the Browning-Drake changed to give the utmost in efficiency from screened-grid valves.

By GLENN BROWNING

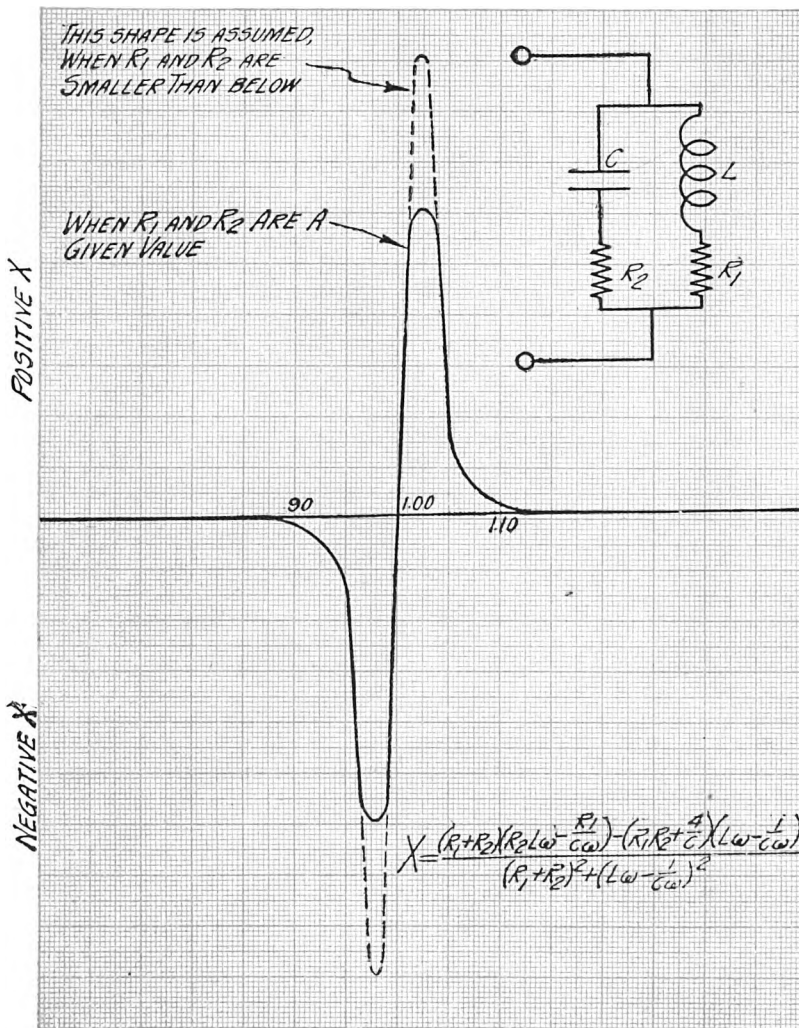
SO numerous have been the requests for data relating to the use of the new screened-grid valves with the Browning-Drake kit-set that it is thought advisable to give radio fans all the information possible at the present time. The circuit built around this valve has been experimented with for the last three months, but not until neutralization was used did the valve perform in a manner which came up to expectations. With the use of neutralization and a regenerative detector the high-frequency amplification obtained was tremendous, so that signals that were inaudible before were as loud as locals, provided the noise and interference was not such as to drown them out. The selectivity of the receiver with the ordinary antenna is somewhat

inferior with this valve used as a high-frequency amplifier. However, with a short antenna the signal strength is decreased very little and the selectivity is much improved.

As most of the fans probably know, the screened-grid valve has two grids. One grid forms a complete shield around the plate, and screens the other grid. This second grid performs the same function as the grid of an ordinary valve. The screening grid is connected to a 45 volts positive tap, giving it a positive potential of that amount, thus lowering the valve impedance and at the same time breaking up the capacity between the plate and the control grid. The ordinary capacity between the plate and the control grid is detrimental when the valve is used as a high-frequency

amplifier, for when a large positive impedance is built up in the plate circuit, energy is fed from plate to the preceding tuned circuit, through the above mentioned capacity, thus making it necessary to neutralize.

In the screened-grid valve this capacity is broken up into two parts, as is shown in Figure 3, consisting of a capacity between plate and ground, and a capacity between screen grid and working grid, which in turn is made up of the two capacities marked in the diagram. When two capacities are connected in series the resultant capacity is, of course, smaller than the smallest. Thus, if two equal capacities are connected in series, the resultant capacity would be one-half the capacity of either component. Therefore, it may



A REACTANCE CURVE FOR A TUNING CIRCUIT

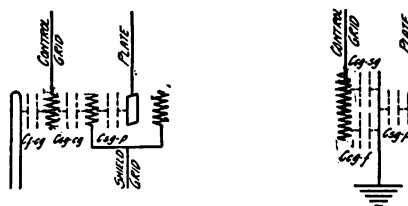
FIGURE 2: These curves show the reactances of the tuning circuit whose formula is given above, and indicates how the positive reactance will vary with the resistance in the circuit, R_1 and R_2 . It is easily seen that the necessary high reactance of the tuning circuit for use with the screened-grid valve necessitate small values of the resistances, R_1 and R_2 .

be readily seen, by referring to the diagram, that although the screened-grid valve cuts down the capacity between the working grid and plate very materially, it is not eradicated entirely. Consequently, in a circuit employing regeneration on the high-frequency transformer, it seems necessary to neutralize the high-frequency amplifier valve.

This may be readily seen by reference to Figure 2, where the reactance of the tuned circuit is plotted against the tuning ratio. The equations for this curve are given and it will easily be noted that the resistance of the circuit enters in, in such a way that the lower the resistance the higher the positive reactance. Thus, with regeneration, one can get almost infinite positive reactance just before the circuit goes into oscillation.

As most radio experimenters know,

the higher the positive reactance in the plate circuit of the high-frequency amplifier valves, the greater tendency there is for the preceding tuned circuit to go into oscillation, due to the feed-back through the capacity between the plate and grid. Thus, even if the capacity between the plate and grid is extremely



A SCHEMATIC REPRESENTATION OF A SCREENED-GRID VALVE

FIGURE 3: This diagram shows how the capacities of the screened-grid valve may be shown schematically. At the right is the result of capacities that exist between the control grid and the plate.

small, the preceding circuit will oscillate before the circuit regenerated on unless this capacity in the high-frequency amplifier valve is neutralized.

The screened-grid valve, as before shown, has a small capacity between the plate and the control grid which should be neutralized if the characteristic efficiency is to be obtained in the type of circuit shown. Incidentally, this capacity which must be neutralized is much smaller than is the case with the 199 type valve.

The screened-grid valve has another advantage by reason of its high amplification characteristic, due to the effect of the screening grid on the mutual conductance of the valve. This tremendous amplification results in great signal strength. On the other hand, the plate impedance of the new valve is very high, and greater efficiency can be obtained by using direct coupling in the tuning circuit, as shown in Figure 4. This makes it altogether imperative that the set-builder use some system of parallel feed.

A parallel feed system has been already adopted in connection with the Browning-Drake for the reason that it keeps the high-frequency currents out of the plate voltage supply, and makes neutralization with the ordinary 301-a type valve considerably easier; consequently adopting the new screened-grid valve as a high-frequency amplifier entails but few changes.

Another essential part of the set built around the screened-grid valve is complete shielding; for, if there is any magnetic feed-back from one tuning circuit to the preceding one, there is a tendency for oscillation to take place in the circuit.

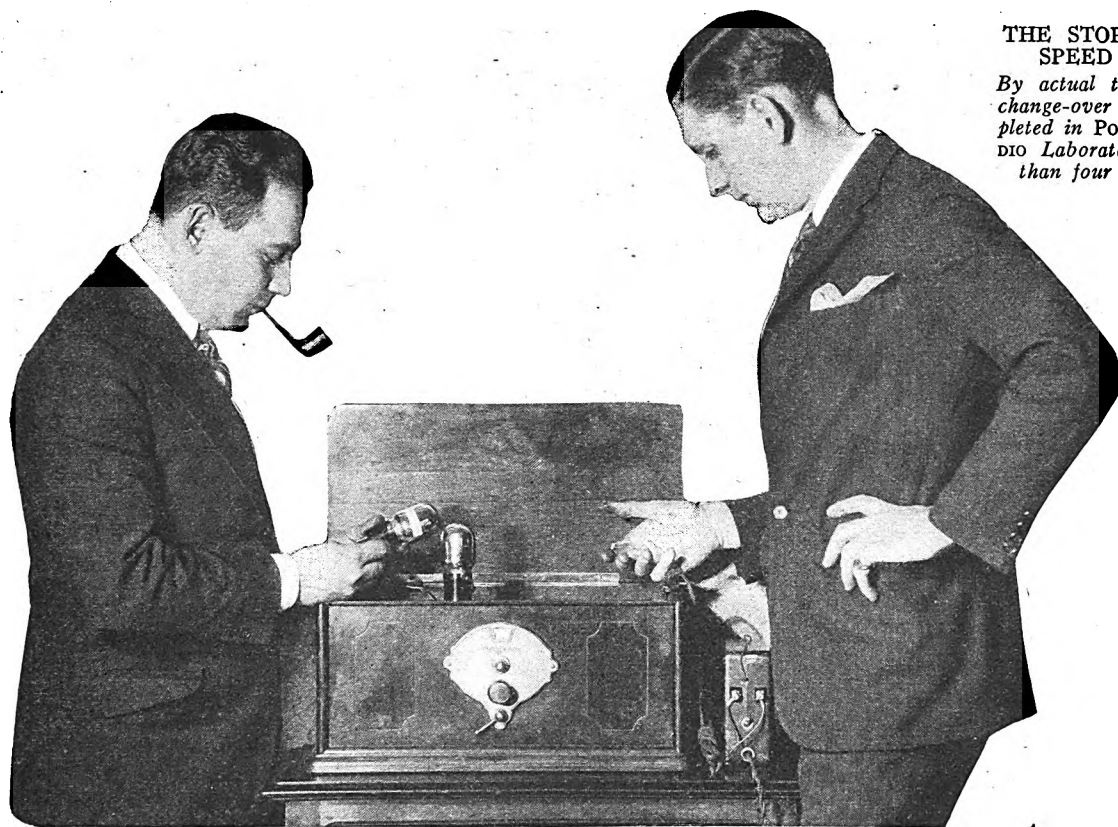
One of the few changes necessary is in the filament circuit, where a 10-ohm and a 5-ohm resistance must be placed in series with the rheostat for cutting down the 5 volts to 3.3 volts, which should be applied to the filament of the screened-grid valve.

A by-pass condenser of at least .5 mfd. should be connected between the screening grid and the ground of the receiver. The grid (G) on the usual four-prong UX socket is the connection for the screening grid, while the cap on the top of the valve connects to the control grid lead. In connecting up the circuit these wiring changes should be kept in mind.

When the connections from the screened-grid valve are made as shown in Figure 4, it will be noted that the capacity between plate and filament is placed directly across the tuning circuit. Thus, it is sometimes necessary to add an equal capacity of about 15

(Continued on page 260)

Q Here, at last, is the "lazy man's adaptor," whereby the complete change from battery to socket operation for valve filament supply may be made by any fan in four minutes!



THE STOP-WATCH SPEED TEST

By actual timing, the change-over was completed in POPULAR RADIO Laboratory in less than four minutes.

4 Minutes to Socket Operation

By P. R. LECKY

WHILE there are hundreds of thousands of set owners who would enjoy the luxury and convenience of socket-operated sets, not many of them have the patience, or even the inclination, to equip their battery-operated receivers with AC valves.

The Marathon AC valve kit enables any novice to change his old receiver to AC operation in less time than it will take to read this comparatively short article. This outfit comes complete with valves, harness and a transformer—the transformer to take the place of the cumbersome "A" battery employed to supply the valves with their filament current. All that is necessary is to install these properly.

In applying this kit, there are absolutely no changes or new connections to be made. Each valve has on its base two special filament or heater connectors. Connecting spades are arranged on the harness, and it is only necessary to slip these spades into place on the special terminals. It will be found that the heater extension connections coming from the cable are

twisted into pairs and it is only necessary to slip these onto the valve terminals, paying no attention whatsoever to polarity connections.

The first operation is simply that of slipping these connections in place. It will be noted that the bases of the AC valves, aside from the special connections, have four standard sized prongs. Two of these prongs are dead. It is these prongs that would normally be connected to the filaments of the valves. The dead prongs are left on the base simply to facilitate changing, and to make the valves fit standard UX sockets.

While all the AC valves require the same heater voltage, the characteristics of the detector are slightly different from those of the amplifier valves; consequently, it will be necessary to place the detector valve in the detector socket of the set.

With this done, all of the old DC valves are removed from their sockets and are replaced by the new group. Both the high-frequency and low-frequency valves have the same character-

istics and, consequently, it is not necessary to make any distinction when placing them in the high and low-frequency sockets.

At the end of the AC harness two terminals will be found. These are connected to the output of the special transformer which is supplied with the kit and which is, in turn, plugged into the AC socket.

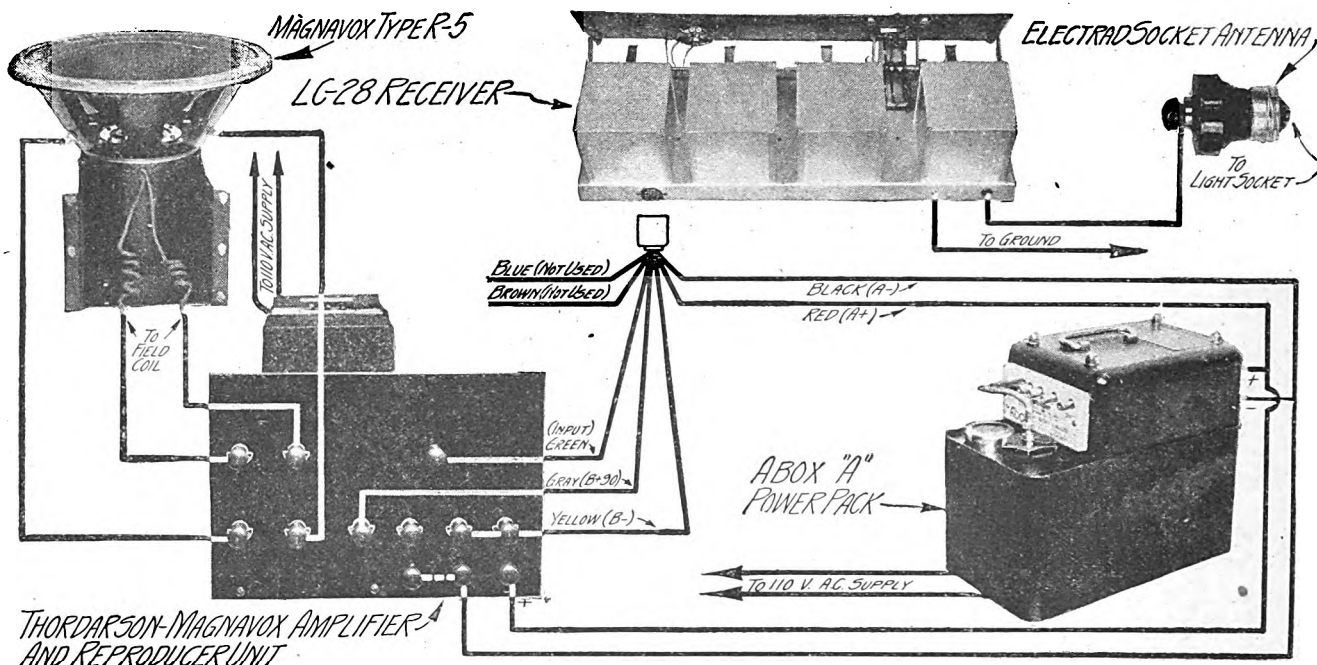
Like all AC valves of the heater type, these valves do not heat up instantaneously and about twenty seconds will be required before it is found that the set is in operating condition.

Just as in the case of the old valves that were employed, slightly better results might be obtained by shifting the high-frequency and low-frequency valves about until best results are had, although in the average case this will not be found necessary.

If the set with which these valves are used is provided with filament rheostats, it should be noted that these regulating devices are no longer operative.

With each kit there is supplied a vol-

(Continued on page 262)



HOW TO INSTALL THE COMBINATION UNIT

FIGURE 1: The Thordarson-Magnavox amplifier and reproducer unit is here shown with the LG-28 high-frequency pack. It gets all its own operating voltages from the lighting lines, and in addition supplies the "B" voltages for the high-frequency pack. The other connections, to ground, antenna and "A" power device, are clearly shown in black lines.

THIS NEW SPEAKER-AMPLIFIER COMBINATION GIVES Radio Luxury in Power Units

Here are the constructional details for a low-frequency amplifier and speaker unit which is the last word in matched combinations for quality reproduction. The operating characteristics of all the parts have been carefully matched for the best results, and the complete unit operates directly from the light socket, and in addition supplies the "B" voltages for the high-frequency pack with which the combination unit is used.

By EDWARD COOMBS

THERE have been made, in the past, many thousands of experiments resulting in partial realizations of what might be termed the ultimate of sound reproduction through the medium of the radio broadcast receiver. These efforts have resulted in the regular broadcast receiver with which most people are familiar, varying in its excellence according to the price paid for the complete job and the excellence of construction in it.

For the man who seeks the ultimate in radio reproduction, there can be no substitute for power amplification. Just as reserve power is so essential for smooth operation of a motor vehicle, just so is a certain amount of reserve power necessary for the low-frequency output, if undistorted reproduction is to be obtained at all frequencies.

Quite naturally this type of amplifier can handle great volumes. Volume, however, is not the only objective, and it may not even be the main objective, any more than an 80-mile-an-hour automobile would ever be driven at full speed through traffic. Just as the excess power of an automobile gives easier control at average speeds, the reserve power of this amplifier provides greater fullness and richness of tone, with less chance of vibration or distortion.

Because the quality of reproduction in a radio set begins with the input to the low-frequency amplifier, excellent results can be achieved only when the entire system, starting from the detector valve and ending with the reproducer, is designed as a single, co-ordinated unit.

The new device described in this ar-

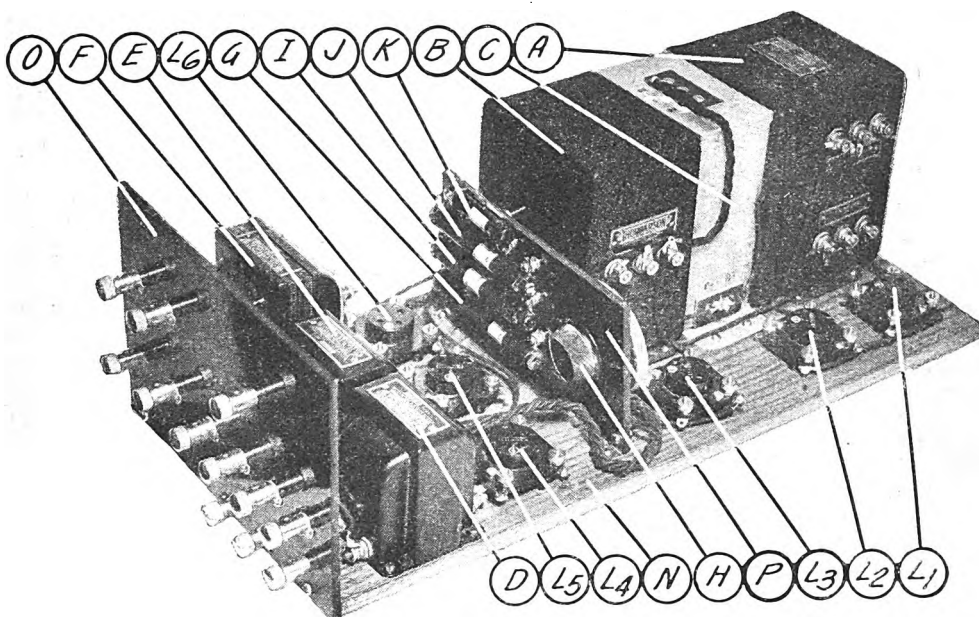
ticle is designed to operate from the 110-volt, 60-cycle house-lighting lines and consists of a single stage of transformer-coupled amplification, followed by a stage of push-pull amplification operating directly into a new reproducer that is especially designed to operate, without distortion, from an extremely large input. In addition, the unit furnishes all the "B" voltages necessary for the high-frequency pack with which it is used.

The new Magnavox reproducer is of the electro-dynamic type and utilizes a free-floating cone. The driving force necessary to put the cone into vibration is not applied to the cone by direct mechanical connection, but by magnetic reaction between a strong, permanently excited field magnet and a light coil

(Continued on page 252)

POPULAR RADIO WORK SHEET

THE THORDARSON POWER-PACK AMPLIFIER



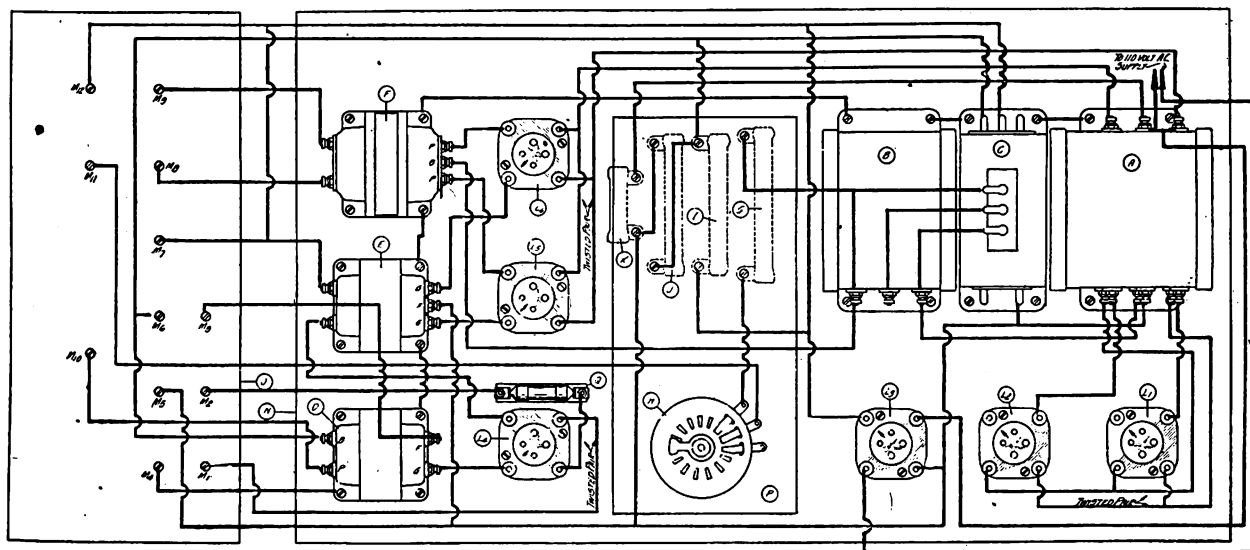
THE PANEL LAYOUT OF THE POWER-PACK AMPLIFIER

FIGURE 2: The unit shown above incorporates a "B" power-pack and one stage of low-frequency amplification which works into the push-pull stage of the power speaker. Note the simplicity of the panel layout of the unit.

LIST OF PARTS FOR BUILDING THIS UNIT

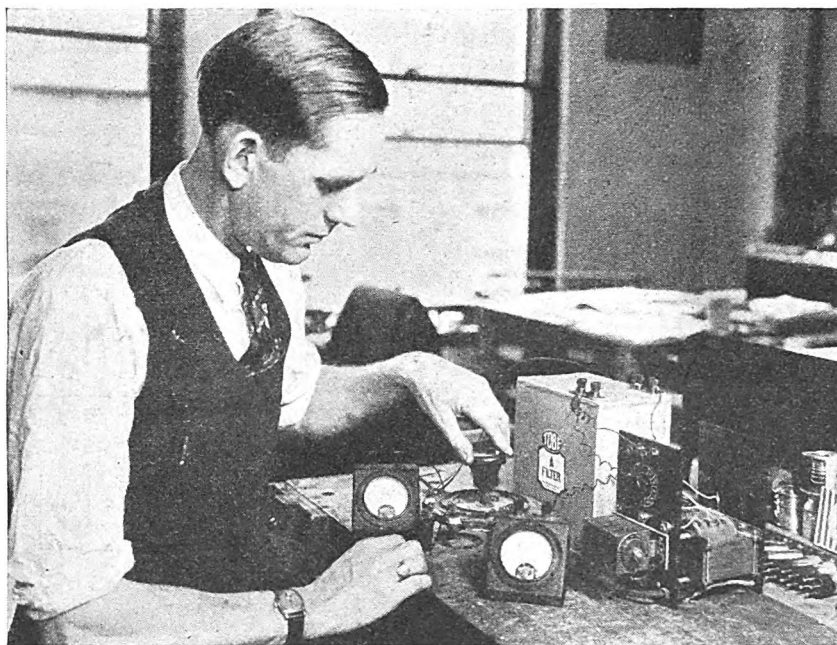
COST OF PARTS—Not over \$94.00

- | | | |
|--|---|---|
| A—Thordarson power transformer, type T-2098; | G—Ward-Leonard fixed resistor, type No. 507-29, 4,000 ohms; | M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11 and M12—XL push posts; |
| B—Thordarson choke coil, type T-2099; | H—Ward-Leonard variable resistor, type No. 508-6, 4,000 ohms; | N—Baseboard, 8¾ by 18½ by ½ inch; |
| C—Tobe condenser, type R-210; | I and J—Ward-Leonard fixed resistors, type No. 508-4, 10,000 ohms; | O—Formica connection panel, 6 by 8¾ by 3/16 inch; |
| D—Thordarson low-frequency transformer, type R-200; | K—Ward-Leonard fixed resistor, type 507-54, 750 ohms; | P—Formica resistor-mounting panel, 4 by 7 by 3/16 inch; |
| E—Thordarson input push-pull transformer, type T-2408; | L1, L2, L3, L4, L5 and L6—Benjamin Cle-ra-tone vibrationless sockets; | Q—Lynch Equalizer, type 4; |
| F—Thordarson output push-pull transformer, V-2629; | | Wire, screws, solder, etc. |



HOW TO WIRE THE POWER-PACK AMPLIFIER

FIGURE 3: All the wiring is done above the baseboard, and is indicated in this diagram in solid red lines. The instruments are outlined in black. The connections between this unit and the power speaker are shown in Figure 1.



TESTING THE OUTPUT OF THE UNIT

It is most important, for the correct operation of valves, that "A" power units deliver a steady flow of current at all the required voltages. The engineer above is testing the Tobe "A" unit with a voltmeter and ammeter to ascertain these characteristics.

Dry "A" Power— from the Socket

With the increasing desire for the elimination of batteries in set operation, this compact "A" unit fills a distinct need. It is easy to build and install, and once installed requires absolutely no attention whatever, as it employs no parts which require servicing.

By STRATFORD ALLEN

WITH the constant advance of radio progress, the problem of converting alternating current from the lighting lines into direct current in sufficient quantity to furnish energy to the filaments of DC vacuum valves has become a relatively simple one.

Efficient rectifiers of the ionized vacuum valve type, and also of the dry and electrolytic types, have been developed to a point where they are thoroughly reliable and give a long period of service.

These rectifiers when operated in a full-wave circuit go a long way in producing the kind of direct current necessary for filament supply, but there is still a very considerable ripple left in the DC wave form, consisting ordinarily of pulsations in the amplitude of

the direct current occurring at the rate of approximately 120 per second.

It is, therefore, necessary to use a filter circuit that will operate on low voltages to store up enough energy to furnish current for the filaments during the period when the amplitude of the rectified energy drops off. This necessitates capacities of very large values, compared with those ordinarily used in radio work, and makes the ordinary form of paper filter condenser too bulky and cumbersome to be economical.

It would need, possibly, 500 to 750 two mfd. condensers of the ordinary paper filter condenser type to reduce the hum to an unnoticeable value. Of course, this is impossible from an operating standpoint.

A recent development has resulted in

a capacity that may be built in the size of the ordinary filter condenser, but that has a capacity thousands of times of that of the ordinary condenser.

This condenser has been incorporated into an "A" power filter known as the Tobe "A" filter. The filter itself contains a regular two-stage choke and condenser circuit utilizing the new type of high-capacity condensers. It is available in a compact form that needs but four connections to place it in operation.

In the following description of a rectifier unit to be used with this filter, a Knapp "A" power transformer and a Knapp full-wave dry electrolytic rectifier have been utilized with a switching arrangement for varying the taps on the transformer to get just the exact voltage necessary for the operation of sets utilizing from one to eight vacuum valves. The "A" power-pack described consists, then, of two items, the "A" filter and the rectifier, which will operate satisfactorily without any servicing whatsoever.

How to Construct the Rectifier Unit

The first job will be to cut two pieces of bakelite to a size of 7 by 4½ by 3/16 inch thick. These should be drilled for the holes necessary for mounting the transformer, as shown in the picture wiring diagram in Figure 2. It will be noticed that the panel, F, is attached to the transformer by four screws and nuts, and the panel, E, is attached to the transformer by four long screws and nuts slipped through four pieces of ¼-inch brass tubing 1½ inches long. The holes for mounting the rectifier, B, the switch, D, the two binding posts, H1 and H2, and the tap switch, C, should also be drilled, as well as the large hole for connecting the AC cord and plug.

After the instruments have been mounted, the wiring should be done exactly as shown in the diagram in Figure 2. It will be best to use a rubber-covered insulated hook-up wire, such as the Corwico brand, for making all of the connections, except the two power leads to the transformer indicated on the diagram by arrows. These should be made with a standard twisted lamp cord and a plug should be attached onto the end.

Check the wiring carefully after it has been completed, to be sure that no mistakes have been made.

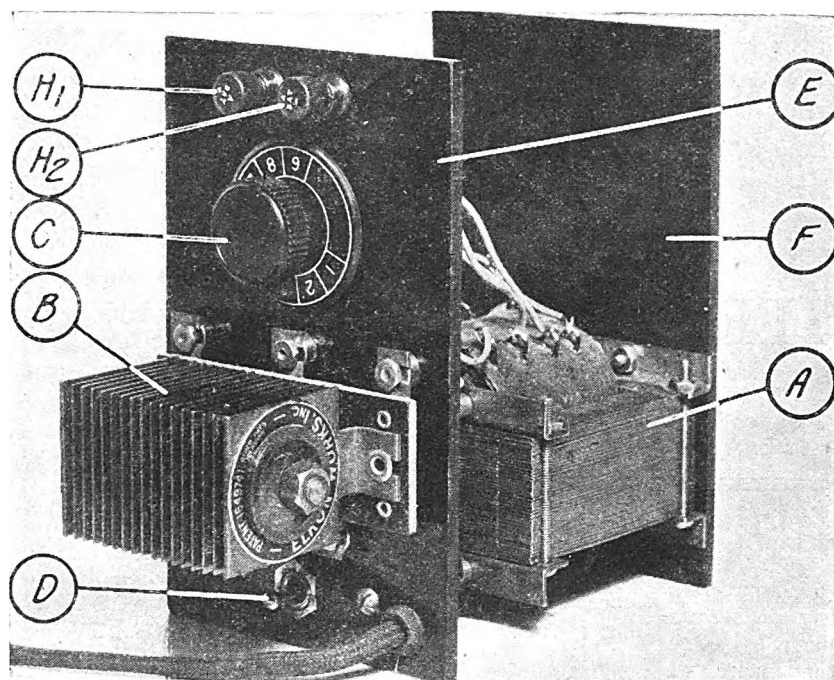
How to Use the Rectifier and the Filter

When all of the connections have been completed, the filter and the rectifier unit may be hooked up to the filament

(Continued on page 252)

POPULAR RADIO WORK SHEET

THE TOBE "A" POWER UNIT



THE LAYOUT OF THE RECTIFIER UNIT

FIGURE 1: The rectifier unit shown here may be assembled in a few minutes, as it consists of only seven parts, all of which are easily mounted and wired.

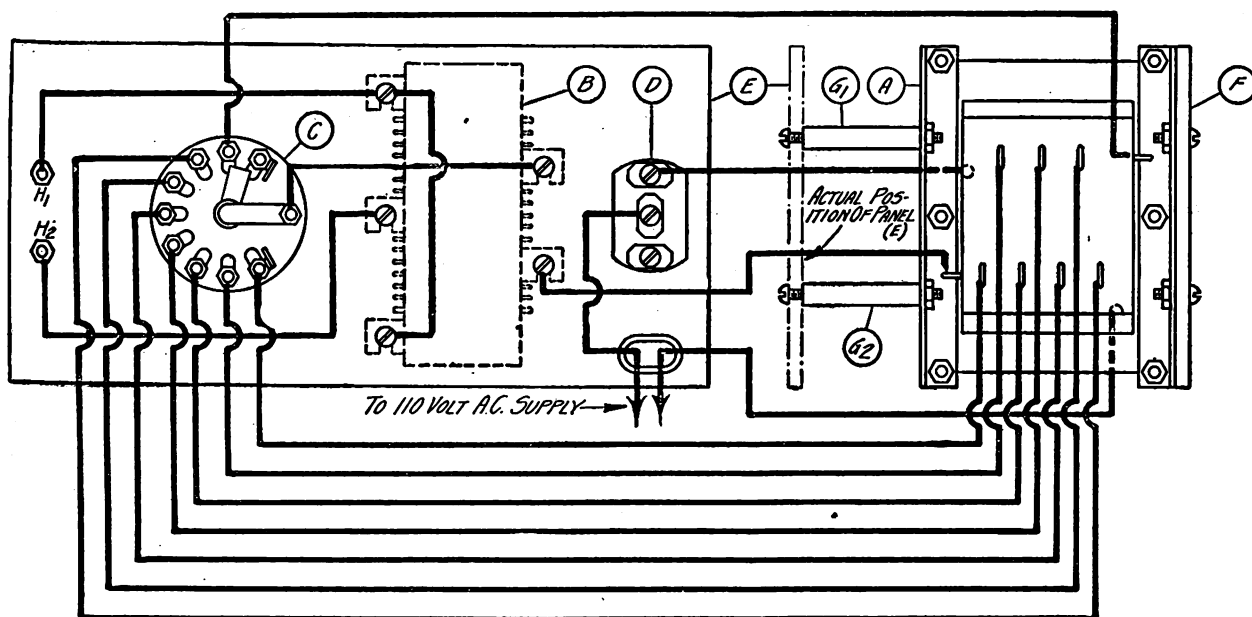
LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS—Not over \$16.00

A—Knapp "A" tapped transformer;
B—Knapp full-wave rectifier unit;
C—Marco tap switch;
D—Cutler-Hammer toggle-switch;
E—Bakelite Micarta panel, 7 by 4½ by 3/16 inch;

F—Micarta panel, 7 by 4½ by 3/16 inch;
G1, G2, G3 and G4—¼-inch brass tubing, 1½ inches long, equipped with 2-inch bolt and nuts;
H1 and H2—Eby binding posts,

marked "A" battery positive (+) and "A" battery negative (—), respectively;
Lamp cord and plug;
Corwico hook-up wire, screws, solder, bolts, etc.



HOW TO WIRE THE RECTIFIER UNIT

FIGURE 2: The wires are shown in this diagram in solid red lines and the instruments are outlined in black. For purposes of clearness, the panel and transformer are shown in one plane. The actual position of the panel is shown in dotted lines.



LISTENING IN

PRACTICAL pointers from experimenters and broadcast listeners. What helpful hints can YOU offer to your fellow fan? Readers are invited to address their letters to the Editor of this Department.

CONDUCTED BY DAVID LAY

How I Combined Radio and the Phonograph

I AM sending several diagrams (see Figures 1 and 2) of a successful scheme I have worked out, which I believe will be of interest to other readers. I have a Stromberg Carlson six-valve receiver and a Western Electric power amplifier with a 36-inch cone; I also have a Bristophon unit for use when I wish to reproduce phonograph music electrically through the power amplifier and the cone reproducer.

The value of this circuit lies in the fact that I can switch the power amplifier from the radio set to the phonograph by the simple expedient of throwing a single switch. Thus on nights when old man static is unbearable all that is necessary is to throw over the switch and use the phonograph for the evening.

When the switch is thrown to the "receiver" side everything is the same as in a normal installation, so that when the battery switch on the receiver is

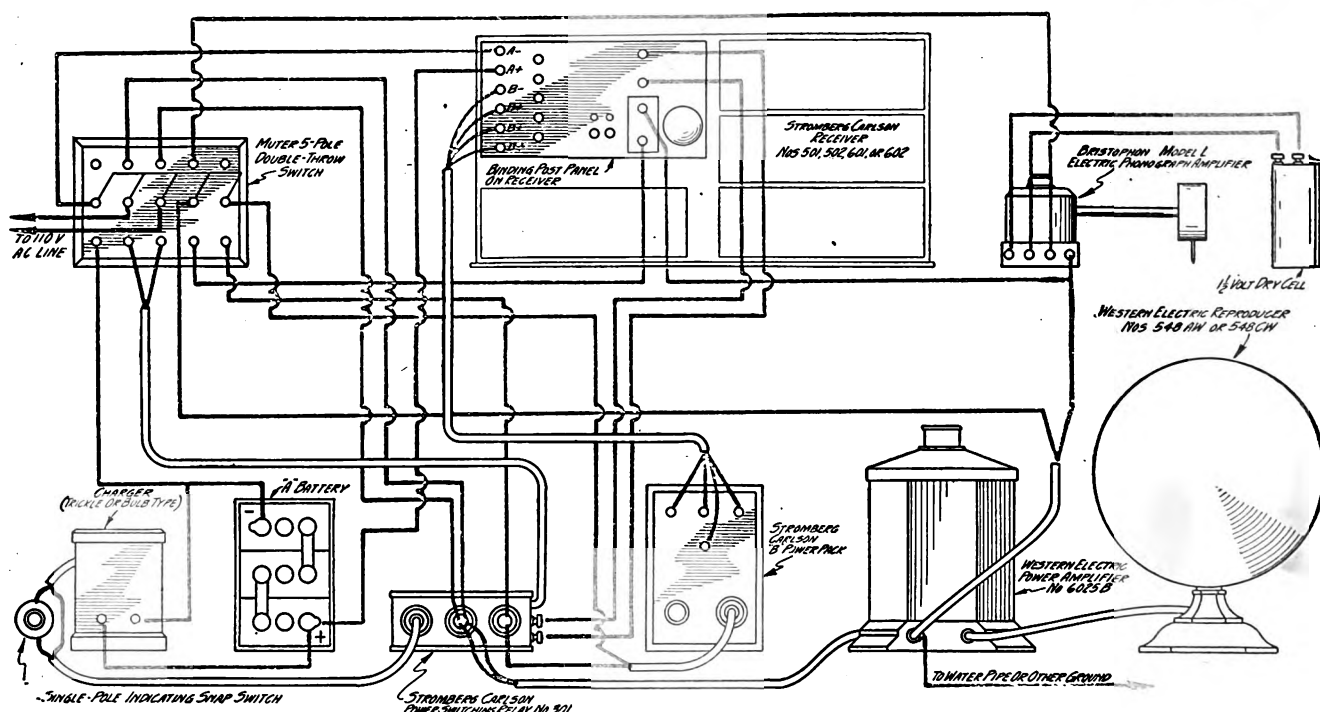
turned "on," the automatic relay is put into operation and thus connects both the "B" power-pack and the power amplifier to the AC line and at the same time cuts off the AC supply to the battery charger.

When the main switch is thrown to the "phonograph" side the receiver is completely cut "off" due to the breaking of the filament supply circuit and also the AC supply to the power-pack and to the relay. The power amplifier AC supply remains unbroken, however, and the phonograph output is fed into the power amplifier.

The diagram in Figure 2 shows the physical layout of the entire installation. The symbolic numbers used in this diagram represent the following instruments and parts:

- No. 1—single-pole indicating snap switch;
- No. 2—charger (trickle or bulb type);
- No. 3—standard 6-volt storage battery;
- No. 4—Western Electric power amplifier, No. 6025B;
- No. 5—Stromberg Carlson 501, 502, 601 or 602 receiver;
- No. 6—Stromberg Carlson power-switching relay, No. 301;
- No. 7—Muter 5-pole, double-throw switch;
- No. 8—Stromberg "B" power-pack;
- No. 9—Bristophon electric phonograph amplifier, Model L;
- No. 10—1½-volt dry battery;
- No. 11—Western Electric No. 548-AW or 548-CW cone reproducer;
- No. 12—any type of phonograph.

(Continued on page 258)



A HOOK-UP FOR ALL-ROUND PROGRAM REPRODUCTION

FIGURE 1: Although this wiring scheme looks somewhat complicated, it could be duplicated by almost any fan in a short time, and the results, combining the best in broadcast reception and reproduction from phonograph records with radio clarity and volume, should be a pleasure to the most critical. As may be noted in the diagram, the hook-up is operated entirely from the light socket, and the change-over from radio to phonograph reproduction is accomplished by the single switch at the upper left.



From a photograph made for POPULAR RADIO

PREPARING A TEST ON AMPLIFICATION TRANSFORMERS

The engineer is comparing the frequency of a standard 60-cycle tuning fork with a frequency of a sine-wave oscillator that is used to generate currents of a single frequency for obtaining amplification curves on low-frequency apparatus. Curves of this type are shown in Figures 1, 2 and 3.

FACTS THAT FANS DO NOT KNOW ABOUT Better Amplification

Do you know the factors in an amplifier that govern the quality of tone coming out of your loudspeaker? Do you know why some sets sound high and tinny and others sound full and robust? Do you know how to choose an amplification system that will give the best results for the money you wish to spend? Here is valuable information by an authority on this subject—

PROFESSOR E. L. BOWLES *

THE question will undoubtedly arise, "What transformer should I choose?" This question is no more readily answered in a few words than, "What automobile should I choose?"

In the first place there is the question of the turns ratio.

The designation of a transformer by "ratio" is no more complete than the arbitrary designation of an automobile

motor's horsepower by its cylinder dimensions. Two transformers may have the same ratio of secondary to primary turns, and yet they may be *very different* in their operation. For illustration: it would be possible to make a transformer of 3 to 1 ratio with but one turn for the primary and three turns for the secondary winding. If this transformer were used, it would give no results, assuming an ordinary core were used.

In practice thousands of turns of wire are used as the primary winding and more thousands of turns of wire as the secondary winding. As a rule, the better transformers have a greater number of primary turns. Since copper is expensive, it is, of course, cheaper to use as little as possible. As a consequence, one 3 to 1 transformer may give a high amplification of the lower frequencies and another a very low or poor amplification of these frequencies.

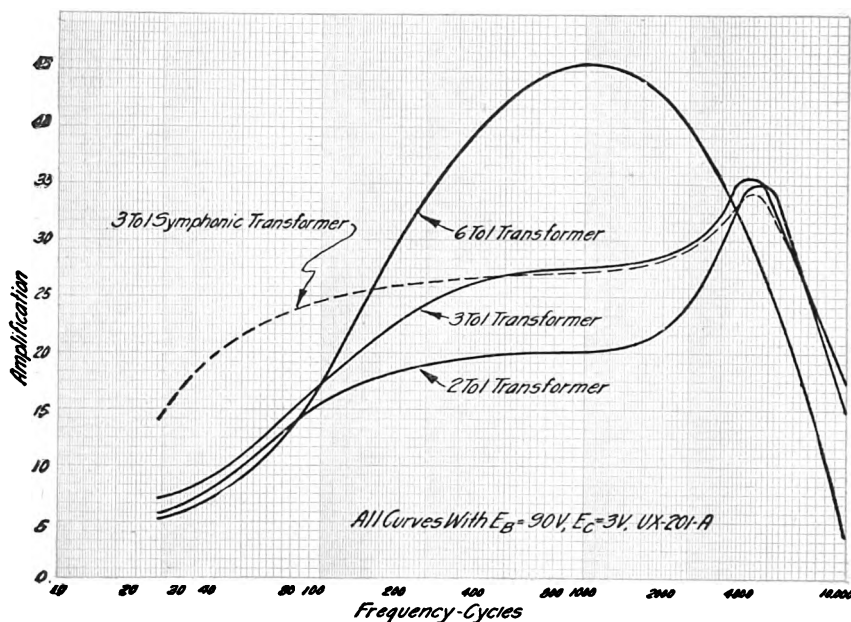
The lower the ratio of the transformer chosen, the less the overall amplification for a given number of stages, but the better the quality *if* the transformer is properly designed. The lower the ratio of the transformer, the greater the number of stages necessary.

However, a 6-1 ratio transformer does not give twice the overall amplification given by a 3-1 ratio. Furthermore, as the ratio is reduced, the relative amplitude of the lower notes increases, with the result that the apparent decrease in amplification is less than it would be if the amplification were reduced in the same proportion at all points. These facts are brought out in Figure 1.

In general, the 3 to 1 transformer will meet the needs of most users. A transformer of this ratio, coupled with the shunt resistor volume control across each transformer secondary, will give great flexibility as to quality and volume. For still better quality at the same volume, the special transformer in Figure 1 is without equal, in the author's opinion. In some cases two 3 to 1 transformers may give too much amplification, so that one 2 to 1 and one 3 to 1 may be used. Again, two 3 to 1 transformers may not give enough amplification, but three may give too much. A 2 to 1 transformer may be added, or three stages of 2 to 1 transformers used.

There is no particular argument to justify the use of transformers of composite ratios in an amplifier; that is, a 3 to 1 and a 2 to 1 and so on. Some have recommended this as standard practice; but often it will be found that the contender was not able to make two

* Dr. Bowles, whose articles on low-frequency amplification have been appearing in POPULAR RADIO during the past months, is on the faculty of the Massachusetts Institute of Technology, and is widely known as an authority on low-frequency amplification.



HOW TURNS RATIO AFFECTS TRANSFORMER AMPLIFICATION

FIGURE 1: Notice how the solid black curves for the three ordinary transformers flatten out as the turns ratios of the windings decrease. The dotted curve is for a symphonic transformer using special core material, and shows very efficient overall amplification.

or more stages of the same ratio stable. It has often been suggested that if composite ratios are used, the high-ratio transformer should be in the first stage and the low-ratio transformer in the second stage.

Actually, from the viewpoint of uniform amplification of all frequencies, if the detector valve is operating on a low voltage, such as $22\frac{1}{2}$ or 45, it is better to have the lower ratio transformer im-

mediately follow the detector valve. The reason is that the lower the plate voltage, the higher the internal plate resistance of the valve. A low-frequency transformer will amplify the lower notes less and less as this plate resistance increases, whereas the amplification of the higher notes is not affected the same in this proportion.

In the case of the dry-cell valves, such as the UX-199 type, it will be

found that the quality will be improved if lower ratio transformers are used. The 2 to 1 will do particularly well here, owing to the high primary impedance of the transformer and the high internal resistance of the valve combined with the lower overall amplification.

The high- μ valves should not be used between transformers, as they are not designed for this purpose, nor is the transformer designed to work with them.

Types of Transformer Distortion

There is distortion in all amplifiers. The problem is to reduce it to such a point that it is unnoticed and undetectable. Figures 1 and 2 illustrate what may be called *frequency distortion* in different low-frequency amplifiers. By frequency distortion is meant the relative difference in the amplification of electric waves of different frequencies. The curves show that the impedance amplifier is apparently more impartial than the transformer amplifier in its amplification of audible waves of different frequencies.

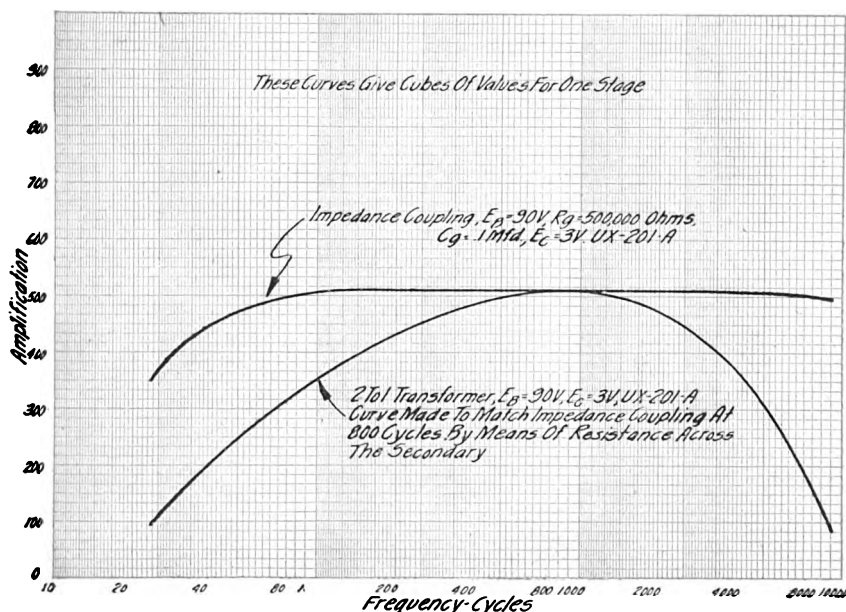
A comparison of a hook-up of three stages of impedance coupling with three stages of 2 to 1 transformer coupling is made in Figure 2. This figure will give some idea of the relative frequency distortion in the different cases.

Another type of distortion may be called *harmonic distortion*. By harmonic is meant the insertion of harmonics by the amplifier itself. That is, if a pure tone of 1,000 cycles per second is impressed on the microphone of a broadcast station, what comes out of the speaker of the receiving set may be a 1,000 cycle per second plus a 2,000 cycle per second tone, plus perhaps even more such frequencies which are integral multiples of the original pure tone. To be sure, these undesirable harmonics may be small in magnitude, but they do, nevertheless, affect the quality of a note.

Such harmonics may be introduced by the valves and by the iron in transformers. The better the transformer iron and the transformer design, the less this distortional effect.

The louder the signal, the greater the tendency toward harmonic distortion. Oftentimes a distortion will not be noticed until the reproducer volume is increased. The consequent distortion, if noticeable, may be due to many things, such as poor broadcast station program apparatus and technique, too selective a radio receiving set, too much regeneration, regeneration at too many places, poor detection, poor amplification, poor reproduction, or a combination of these. The transformer is not always to blame.

Distortion which may creep into low-frequency amplifiers, or which may already be there, may be due to improper battery connections or improper



CURVES FOR IMPEDANCE AND TRANSFORMER COUPLING

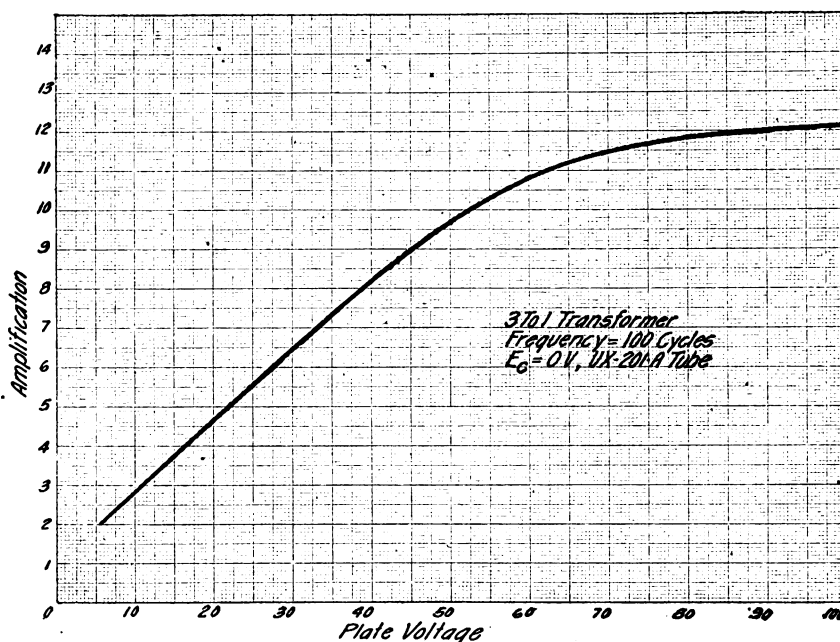
FIGURE 2: A three-stage, impedance-coupled amplifier gave the curve shown at the top, and a transformer-coupled amplifier the lower curve. This curve does not, however, represent the best that may be obtained with transformers.

battery voltages. Too low a filament voltage will not only lower the output of an amplifier, but it will introduce serious distortions. For instance, in the transformer-coupled amplifiers of Figure 4, too low a filament current will cause the output from the reproducer to sound "tin-panny." If the operator should deliberately decrease the filament currents of the detector and low-frequency amplifier valves, he would observe that the lower notes would disappear first, and that the remaining bare tinny notes would disappear gradually.

The volume from any amplifier should never be controlled by varying the filament current of the low-frequency valves. The filament current or voltage should be kept at the rating specified by the manufacturer. Use a voltmeter to determine the proper value.

The "B" battery voltage should be that specified by the manufacturer. One may reduce the "B" voltage in the amplifier valves and say that it has no effect, but he is usually mistaken. This conclusion may be the fault of an insensitive ear, a prejudice or an incomplete test.

Figure 3 shows how the amplification varies with "B" battery voltage in a transformer-coupled amplifier utilizing UX-201-a type valves. As the "B" battery voltage is increased beyond 50 volts the amplification does not change so much. Actually this is only a part of the story, since the signal voltage applied to the amplifier was very small in this case. A larger signal voltage would show distortion with a "B" battery voltage of 60, whereas a perfectly clear signal would result with a "B" battery voltage of 100. That is, the larger "B" battery voltage, in addition to increasing the volume of



A PLATE-VOLTAGE AMPLIFICATION CURVE

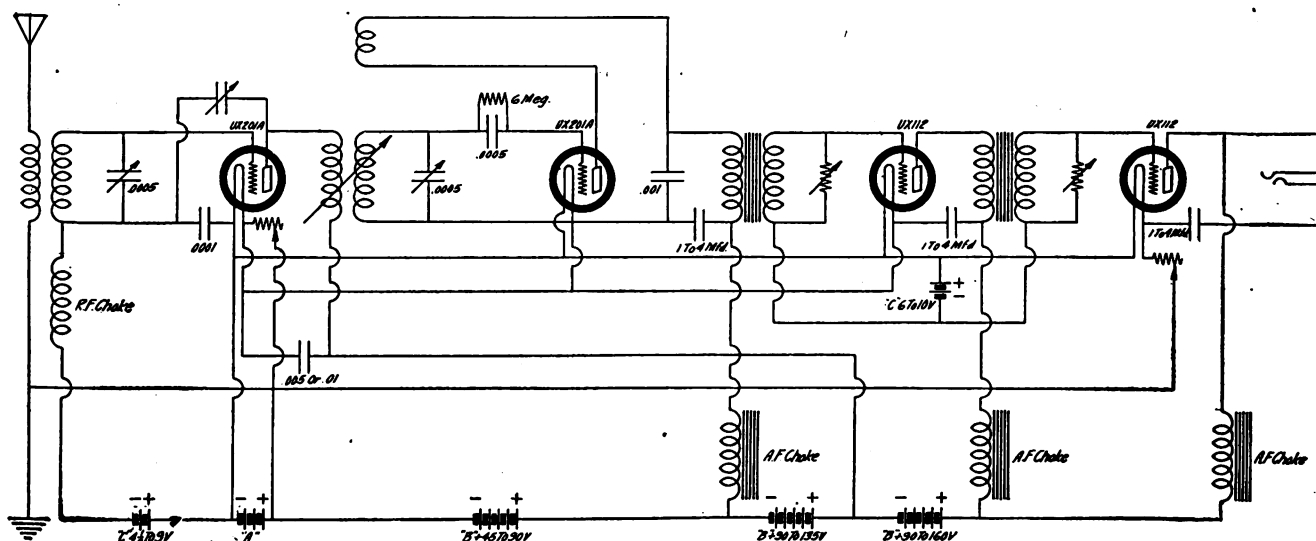
FIGURE 3: This graph shows the increase of amplification obtained with a standard vacuum valve as the plate voltage is increased.

the signal, enables the amplifier to handle more volume without distortion, or more volume with a given permissible distortion. There is the additional advantage that the larger voltage will cause a larger amplification of the low notes in proportion in a transformer or impedance-coupled amplifier. In general, for the best low-frequency amplification with given valves, they should be operated at the higher "B" battery voltage recommended by the manufacturer. The higher voltage will result in clearer tones and more brilliancy of reproduction.

The detector voltages, in the case of

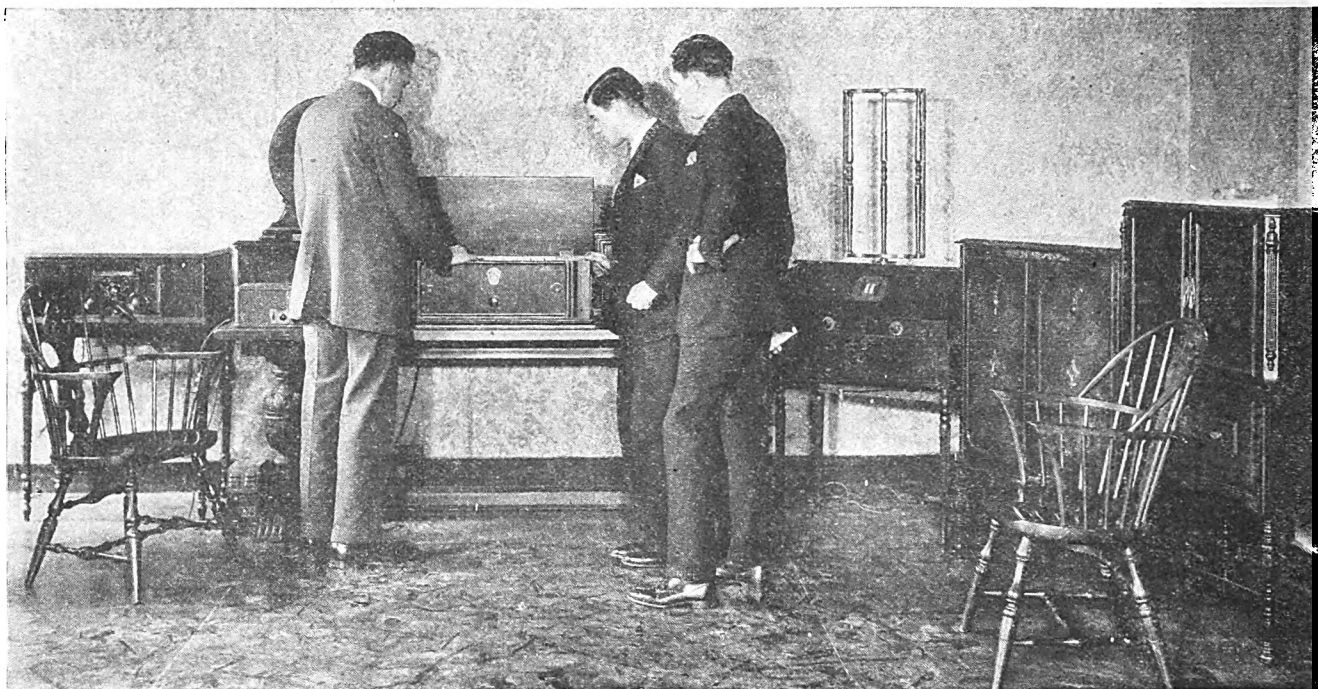
hard detector valves such as the UX-112 type, the UX-201-a, and the UX-199 type are not critical, as these valves will detect efficiently at various plate voltages. Consequently, in the case of transformer-coupled amplification particularly, and in cases of all other forms of coupling, it is advantageous to keep the detector plate voltage high, for although this is not a requisite for the detector valve as a detector, it is advantageous for the valve as an amplifier. The detector valve (using grid-leak and grid condenser) acts not only as a de-

(Continued on page 240)



TRANSFORMER-COUPLED AMPLIFICATION IN A RECEIVER CIRCUIT

FIGURE 4: Two stages of transformer-coupled low-frequency amplification are shown at the right in this schematic circuit of a receiver. The variable resistances across the transformer secondaries are for volume control.



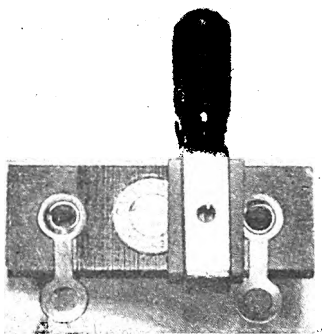
WHERE POPULAR RADIO SERVES ITS PUBLIC

This picture shows the demonstration room at POPULAR RADIO'S headquarters, where the various receivers and accessories that are tested in the Laboratories are put through their paces before radio manufacturers. This co-operation between POPULAR RADIO and the radio manufacturers results in improved apparatus for the fan and set builder.

What's New *in* Radio

Conducted by
THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.



A Compact "C" Biasing Resistor Unit

Name of instrument: "C" biasing resistor, variable.

Description: This potentiometer is wire wound on a bakelite strip. The winding terminates in soldering lugs and the slider is so designed that it can be locked in place after the proper adjustment has been made. The unit is made in various resistances so it can be used as a filament shunt re-

sistor with variable center tap for mounting directly on the sockets of AC valves; or it may be used in power-packs to provide either one or two "C" biasing voltages.

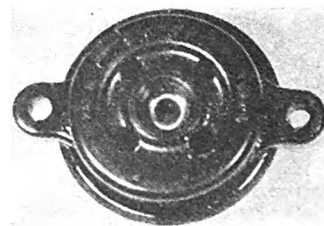
Outstanding features: Small enough in size to mount directly on filament terminals of AC valve sockets. Simple and sturdy. Inexpensive. Available in resistances from 50 ohms to 2,500 ohms.

Maker: Carter Radio Co.

Handy Valve Sockets for the Home Constructor

Name of instrument: Na-ald valve socket, type No. 424.

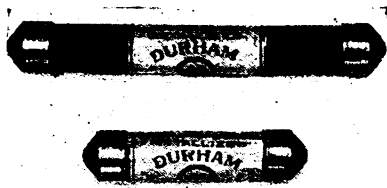
Description: Moulded bakelite is used for encasing this socket. The socket is so designed that it may be mounted either above or below the sub-panel of a receiver. In the former case it projects about $\frac{3}{8}$ inch above the sub-panel; when mounted beneath the panel, the top of the socket is flush with the top of the sub-panel. Mounting lugs extend out from two sides



of the bakelite case and the contact springs extend out through the bottom of the case to provide connection terminals. Good contact is made with the valve prongs. The holes in the top of the case are set down in a depressed ring to facilitate inserting the valve; this ring is colored red for sockets for the 226 type valve, green for the 227 and yellow for power valves.

Outstanding features: Easy to insert valve. Good contacts. Small size. Universal mounting. Small jack included in socket for connecting grid suppressor resistance unit.

Maker: Alden Mfg. Co.



Small Size Resistors for Heavy Loads

Name of instruments: "Powerohm" medium-duty, high resistances.

Description: These resistances are designed to dissipate $2\frac{1}{2}$ watts and are made in various values from 250 ohms up to 250,000 ohms. They have the advantage that at maximum load the resistance change is less than 10 per cent. The resistance element used consists of a glass filament which is coated with a conducting material that is baked on to form a homogeneous conducting surface of high resistance and permanent character. This permanency is aided by a coating of insulating varnish which protects the resistance coating from atmospheric changes. The whole unit is then inclosed in a glass cylinder with metal end caps which are connected to the extremes of the resistance element. In physical appearance these resistance units resemble standard grid-leaks. The smaller of the two sizes shown is the same length as an ordinary grid-leak, but of slightly larger diameter. The larger unit is of the same diameter as the smaller one, but about an inch longer. Both sizes have the same power rating.

Usage: As coupling resistors or as resistors in power circuits where they will dissipate not more than $2\frac{1}{2}$ watts continuously.

Outstanding features: Accurate resistance rating. Resistance change less than 10 per cent under full rated load. Resistance value permanent.

Maker: International Resistance Co.



A Heatproof and Moisture-proof Condenser

Name of instrument: Mica fixed condenser.

Description: The condenser element is carefully prepared from high-grade mica and tinfoil and is thoroughly impregnated to bind it. It is then moulded under high pressure into a bakelite covering so that the completed condenser is a solid block of bakelite with the condenser element sealed in the center and connection terminals from the latter projecting out through the ends of the block. These terminals are carefully designed to afford ample surface for soldering. The capacity of each condenser is clearly stamped in the bakelite.



A Complete Line of High-Grade Condensers

Name of instrument: Parvolt fixed, by-pass and filter condensers.

Description: This group of condensers represents the line formerly marketed under the name Sangamo.

The fixed condensers employ mica as the dielectric and are moulded in bakelite blocks. Thus they are moisture proof and of unvariable capacity. They are equipped with metal terminals in the form of threaded brass bushings, which extend through the block and permit connections to be made on either or both sides of the condenser terminals. These small condensers are accurately rated as to capacity. Clips, as shown in the picture, may also be obtained to attach to the condenser terminals where it is desired to mount grid-leaks or resistors in shunt with the condensers.

The small by-pass condensers shown are of the "wound" type and employ a high grade of condenser paper as the dielectric. They are inclosed in metal cases with lugs at the bottom for mounting in an upright position. The condensers are hermetically sealed in cans and are provided with soldering lug terminals which extend

up through the wax in which the condenser windings are imbedded. These by-pass condensers are rated for continuous service at 400 volts DC, which is sufficiently high to permit their use for all by-pass work in receivers and in the output circuits of 180-volt "B" power-packs.

The filter condensers are similar to the by-pass condensers in construction, but are larger and will withstand higher potentials. They are obtainable in capacities from 1 to 4 microfarads. They also employ high-grade condenser paper as the dielectric. These condensers are rated at 800 and 1,000 volts DC continuous service. These high ratings permit the use of these condensers in heavy-duty "B" power-packs such as those used to supply the high operating voltages required for the 210 type of power valve. Heavy mounting feet are provided on the larger condensers.

Outstanding features: Each condenser accurately rated as to capacity and voltage at which it may safely be used for continuous duty. Easy to mount. Sturdy and durable.

Maker: Acme Wire Co.

Usage: For any purpose which requires a fixed capacity within the range of .00004 mfd. to .02 mfd.

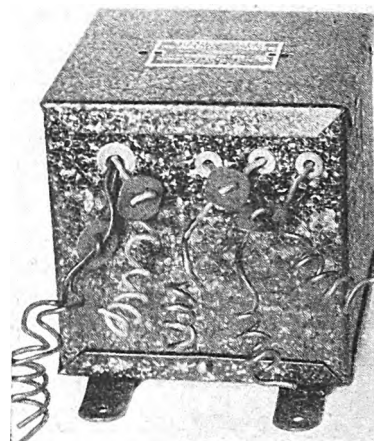
Outstanding features: Capacity constant regardless of atmospheric conditions, heat applied in soldering or rough usage. Neat appearance. Guaranteed accurate within 10 per cent.

Maker: Aerovox Wireless Corp.

A Transformer for "ABC" Power-Packs

Name of instrument: Power supply transformer, No. 3591, for power-packs.

Description: This transformer is designed for use with the Raytheon BA-type rectifier valve, to supply the "A," "B" and "C" voltages for receivers that use standard UX-201-a type valves wired in series. This valve requires a transformer with a center-tapped secondary winding to supply 350 volts each side of the tap. This voltage is provided in this transformer, and in addition there is a 5-volt center-tapped winding to supply the filament current for the operation of a UX-171 type power valve in the last low-frequency stage of the receiver. This transformer is com-



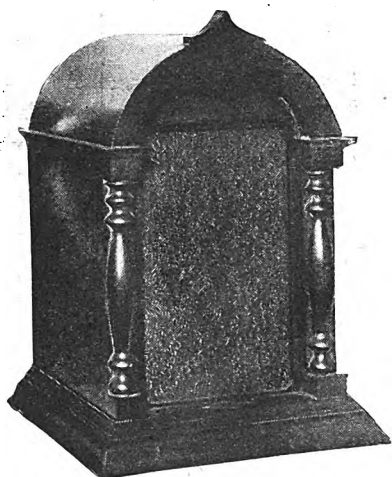
pletely inclosed in an iron case with a black crackle finish.

Usage: To provide input voltage for a Raytheon BA-type power-pack; also filament voltage for the operation of a UX-171 type amplifier valve.

Outstanding features: Good construction. Neat appearance. Fully safeguarded against the danger of shocks.

Maker: Dongan Electric Mfg. Co.

New Results With



The Consomello Horn

A 3-Foot, Air-Column Horn in a Decorative Cabinet

Name of instrument: "Consomello" horn-type reproducer.

Description: In general appearance this reproducer is somewhat similar to many of the present-day inclosed cone reproducers. Actually it contains a horn with an air column which is approximately 3 feet in length. This horn is curled up into compact dimensions, which explains how it is possible to accommodate it in a cabinet of such small dimensions. The cabinet is well made and decorative in appearance. The open front is protected by a textile material which adds to the appearance of the reproducer without in any way interfering with the tone quality or volume.

Outstanding features: Design of horn permits it to be inclosed in comparatively small cabinet. Good reproducing qualities. Neat appearance.

Maker: Mazda Radio Mfg. Co.

An Enclosed Cone of Fine Appearance

Name of instrument: Vogue model 12 cone reproducer.

Description: This reproducer is of the drum type in outer appearance. It consists of a metallic case that is crackle finished in dull brown. It is open at the front and rear, with the openings covered with grille work that

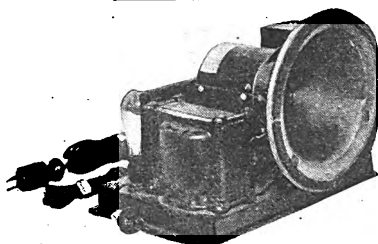


The Vogue Cone

is finished in old gold and backed with silk material of the same color. The reproducer proper is of the cone type and is completely concealed within the metal case. This case serves as a resonance chamber to provide the full round tones so eagerly sought after.

Outstanding features: Pleasing to the eye and to the ear. Neatly finished and well designed.

Maker: Richard T. Davis, Inc.



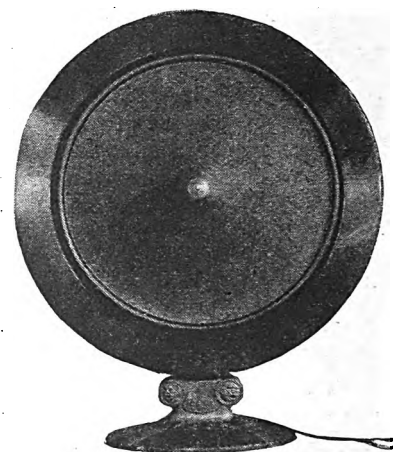
The Magnavox Power Cone Reproducer

A Power Amplifier and Speaker for Any Receiver

Name of instrument: Power cone reproducer.

Description: The Magnavox power cone consists of a stage of power amplification, employing a 210 type valve, a power supply unit to supply the filament and high voltage plate supply for this valve, a cone type reproducer and an output transformer. All of this equipment is mounted on a metal base and makes a compact unit which will easily fit into the reproducer compartment of a console receiver. The unit is intended for use in place of the last low-frequency stage of any receiver and when so used does not require any alterations in the receiver or wiring. An extension cord and plug supplied with the unit is connected into the receiver circuit by inserting it in the last valve socket.

Outstanding features: Provides a fine cone reproducer and a stage of power amplification for use with any receiver.



The Amplion Cone

Compact and easy to connect to receiver. Provides all of its own power requirements, including filament, plate and grid voltages.

Maker: The Magnavox Co.

A Cone With a Wooden Rim and Backing

Name of instrument: Amplion cone reproducer, model AC-20.

Description: Made by one of the oldest manufacturers of devices for the electrical reproduction of sound, this reproducer comes to us well recommended. It consists of a specially prepared fabric cone which has approximately the stiffness of parchment, but is "dent" proof. The cone proper is inclosed at the edge and the back by a wooden sounding board, to which the reproducer owes its mellowness of tone.

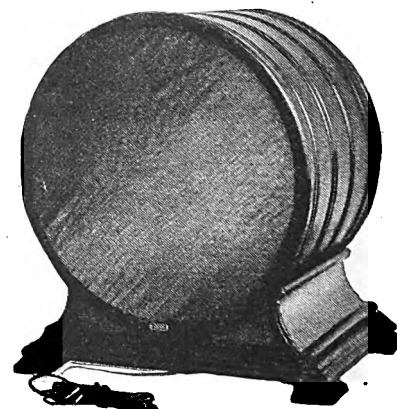
Outstanding features: Wooden sounding board. Free-edge suspension. Built of dent-proof cone material. Contains a genuine Amplion unit.

Maker: Amplion Corporation of America.

A Horn for Full-Throated Reproduction

Name of instrument: Drum speaker No. 18, senior.

Description: This horn, if it were straightened out, would be 75 inches in length, but it is so designed, by curling the smaller part around the flaring output end, that it may be inclosed within a drum-shaped metal case that is only 18 inches in diameter. The reproducer itself is of a special composition material and is moulded to present a smooth internal surface to the sound vibrations. The inner diameter of the horn gradually increases at a carefully planned rate so as to provide natural reproduction with maximum volume, especially on the low base notes. The metal drum in which the reproducer is inclosed is done in a crackle-finished brown and the whole unit is mounted on a substantial base which



The Temple Drum Speaker

adds considerably to its appearance. **Outstanding features:** Natural reproduction with a well-rounded tone quality.

Maker: Temple, Inc.

1928 Loudspeakers

A Decorative Reproducer

Name of instrument: Shield speaker.

Description: Good quality of reproduction and unusually attractive appearance mark this new reproducer. It is a so-called "cone" type reproducer, inasmuch as the large shield-shaped part of the device constitutes the diaphragm and is connected to the driving unit by means of a short drive rod, after the fashion of the usual cone reproducers. The diaphragm is attached to the metal stand at only two points, top and bottom, so that the reproducer is of the free edge type. The pedestal and floor stand are of metal and so designed that the center of gravity is low and the unit is therefore not easily tipped over. The diaphragm is of a composition material similar to celluloid and will neither nick nor dent, as will most paper or parchment diaphragms.

Outstanding features: Good reproduction. Fine and novel appearance. Much less easily damaged than most reproducers. Neatly finished in blue and polychrome.

Maker: Shield Speaker Co.



The Shield Speaker

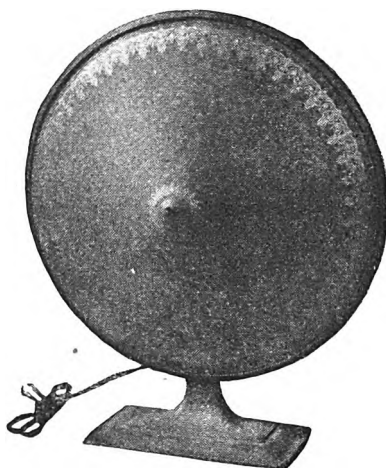
A Medium-Sized Cone of Good Characteristics

Name of instrument: Model 28, "Concerto" reproducer.

Description: The edge of the parchment cone of this reproducer is not rigidly supported. It receives a certain amount of support from the grooved metal band which incloses its edge, but it is permitted to vibrate freely. The reproducer unit is mounted on a metal framework which is rigidly attached to the metal base and also to the grooved ring which incloses the cone edge. The cone is approximately 14 inches in diameter and is attached to the driving rod of the reproducer unit by means of a bushing and a set screw.

Outstanding features: Free-edge action. Moderately price. Neat in appearance. Good reproduction.

Maker: Trimm Radio Mfg. Co.



The Concerto Reproducer

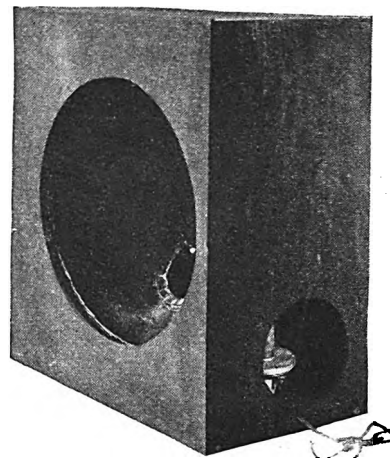
An Eight-Foot Horn in a Two-Foot Space

Name of instrument: "Console Grand" exponential horn.

Description: The air column of this exponential type horn is 86 inches in length, but the horn is so arranged that it occupies a space of only 25 inches by 19 inches, which is the size of the rectangular flaring bell of the output end. The horn is of composition material and is well designed as regards shape and material, both of which are factors of extreme importance in a horn-type reproducer. The reproducer unit is a Baldwin. The horn is obtainable equipped with any one of several different types of cabinets. These cabinets are of table height and if desired the radio receiver may be placed on top of the reproducer cabinet.

Outstanding features: Excellent reproduction over the entire range of audible frequencies. Free, natural reproduction of the low bass notes particularly noticeable. Presents a fine appearance when inclosed in any of the wood cabinets which may be obtained for it.

Maker: Racon Electric, Inc.



The North Vernon Horn

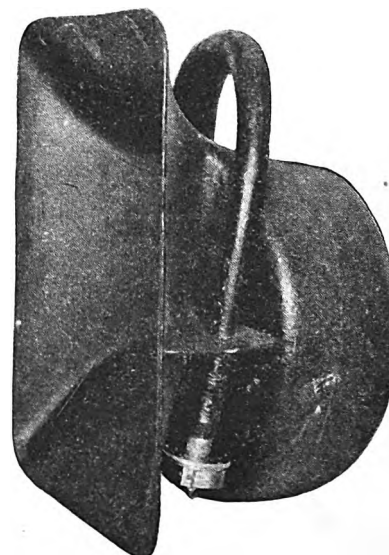
A Reproducer for Enclosure in a Console Cabinet

Name of instrument: Horn-type reproducer.

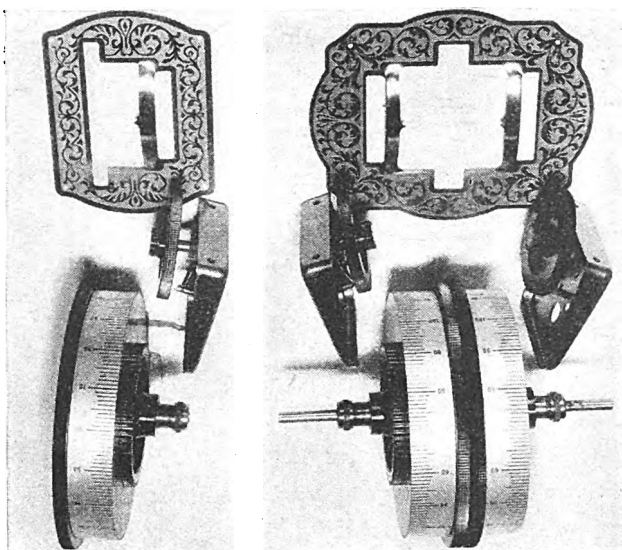
Description: This reproducer is intended to fit inside of console cabinets that have a compartment provided for this purpose. Some consoles already include reproducers of inferior quality, while others provide the space, but are not equipped with a reproducer when purchased. This reproducer is of the horn type, but is so designed that the more slender portion of the horn is curved and nestles around the expanding portion of the bell-shaped opening. The horn is of composition material and is inclosed within a wood case of rectangular shape. A hole is provided in one side of the case, through which the small end of the horn is accessible for attaching the reproducer unit. The front of the case is cut away over the mouth of the horn.

Outstanding features: Good quality. Plenty of volume. A convenient accessory for those who wish to conceal the reproducer.

Maker: North Vernon Lumber Mills, North Vernon, Ind.



The Racon Horn



Drum Dials for the Home-Built Receiver

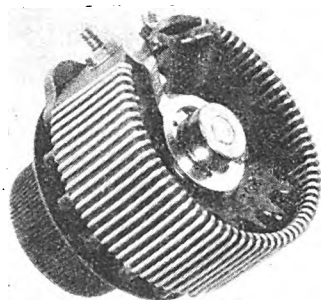
Name of instruments: Single or double drum dials.

Description: The single dial shown above consists of the large drum with a calibrated scale, knurled edge and gear wheel, a mounting bracket, and an escutcheon plate. In a single-control receiver all tuning condensers are mounted on a single long shaft, as is also the large drum. The mounting bracket is attached to the receiver panel in such a position that its small gear wheel meshes with the larger gear on the drum. Tuning is then accomplished by means of either of the knurled discs, the one on the mounting bracket or the larger one on the drum, both of which project through the slots in the escutcheon plate. The movement by means of

the large control provides direct tuning, while the smaller one provides a high step-down ratio of vernier action. The double dials function in the same manner, except that they are on separate shafts to control separate tuning condensers or groups of condensers. These two drums may be manipulated independent of one another or together, in the latter case providing single control. This last is attained by bridging a finger across the adjoining knurled discs and revolving the two together.

Outstanding features: Fine appearance. Excellent workmanship. Smooth action, without back-lash. Provides either direct or vernier control of tuning.

Maker: Tyrman Electric Corp.



An Air-Cooled Filament Control

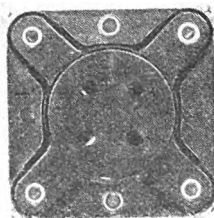
Name of instrument: Filament rheostat.

Description: The resistance winding of this unit consists of wire wound around a composition strip and assembled with this strip curved around the circumference of a corrugated composition block. With this arrangement only about 5 per cent of the resistance surface is in contact with the frame, thus leaving approximately 95 per cent of the resistance surface exposed to circulating currents of air for the dissipation of heat. A spring slider is provided for the variable contact arm and this operates smoothly and with light pressure but perfect contact. The instrument is equipped with a composition knob and may be mounted on

a receiver panel with a single hole. **Usage:** For the control of filament current for from one to ten valves.

Outstanding features: Well made. Permits free circulation of air around the winding. Made in various sizes from $2\frac{1}{2}$ ohms to 75 ohms, with current carrying capacity up to 2 amperes in the case of the $2\frac{1}{2}$ -ohm type illustrated.

Maker: Herbert H. Frost, Inc.



A New Type of Vibrationless Valve Socket

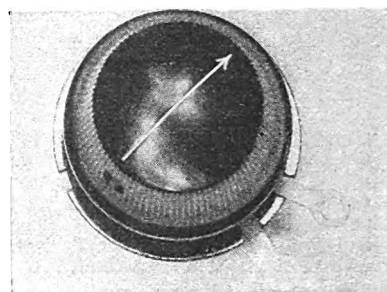
Name of instrument: Cushion radio valve socket, type 3.

Description: The composition base of this socket is rectangular in shape and has a cut-out center in which the composition disc which actually holds the valve is suspended. Suspension is by means of a long double spring, which is entirely insulated from the four socket terminals and therefore from

the valve terminals when the valve is in place in the socket. Contact between the valve prong clips on the under side of the suspended disc and the socket terminals is made through short cables of flexible wire.

Outstanding features: Unusually long suspension springs. Springs do not function as connectors, so there is little chance for poor contacts to valve prongs. Stops are provided to limit movement of suspended portion of socket; thus possible damage to spring is avoided.

Maker: Kellogg Switchboard & Supply Co.



A Handy Volume Control Unit for Any Receiver

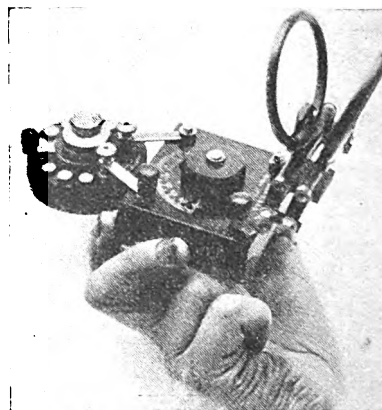
Name of instrument: "Tonatrol" volume and tone control unit.

Description: This unit is a variable high resistance and is similar to a rheostat in appearance. It is equipped with an engraved knob and is designed for single-hole mounting on the receiver panel. When connected across the secondary of the low-frequency transformer in the first low-frequency stage, the volume of reproduction can be smoothly varied from zero to maximum. Also various shadings of tone can be obtained in this same way. The unit is also supplied in the "WS" model, which in addition to the function described above also serves as a filament switch.

Usage: To control the volume and tone of reproduction in a radio receiver.

Outstanding features: Smooth control of volume. Easily installed. In some old-fashioned receivers this unit will improve the tone quality appreciably.

Maker: Electrad, Inc.



A SPORT-MODEL RECEIVER

This unique French receiver that can be held in the palm of the hand employs two ring coils for an antenna and a crystal for detection. It is popular among French fans who take to their bicycles for sport.

I Used to Give Radio Information Away—Now I Sell It

(Continued from page 221)

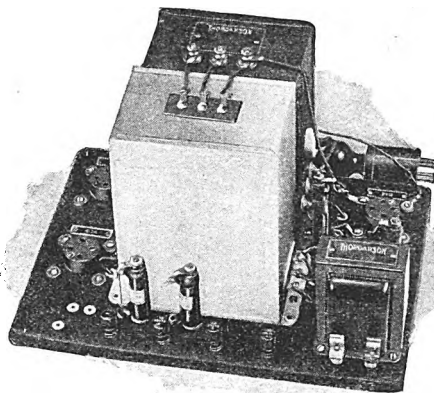
short distance from New Albany. Here I service, during the daytime, standard receivers like the Radiola, Crosley, Atwater-Kent, and other makes of sets. This work, aside from its remunerative value, adds constantly to my experience and permits me to keep my ears to the ground for information that will better my own spare-time business. A radio service man must be familiar with all types of receivers and with the new developments made each year by the various manufacturers. Having a regular service job with an established dealer permits the operator to do this and to actually be paid for his efforts.

Last year, which was a particularly good one for me, I succeeded in booking orders for seventy-two receivers, which ran in size from three to eight valves. The profit on these receivers averaged between \$15 and \$60 per set. In many cases I could have realized a much greater profit on some of these sets, but I preferred to accept a modest profit, being primarily interested in getting satisfied customers. As time goes on and my reputation becomes very firmly established, I shall increase my margin of profit, bringing it up to a more substantial amount.

As I look back over my several years of effort in this field, I realize that my business would have grown more quickly if I had been able to do some advertising in our local newspapers. If a man has a moderate capital to start on, this might be a wise thing to do. But I have worked on the theory that it is the satisfied customers who bring the invaluable "word of mouth" advertising, which, after all, is the very best kind. The only money that I have spent has been in the form of business cards, which I distribute freely to prospects and to customers who might wish to mention my name to friends.

Some day, perhaps, I shall own my own radio shop, and if my present rate of income increases steadily I do not believe that this will be far off. My experience in servicing has proven that it does not make very much difference what receivers you sell, providing you can give them intelligent service. I believe that the whole foundation of radio merchandising rests upon sound dealers' service. And a man starting out in retailing radios with a good knowledge of radio will be found to do more business than the opportunist around the corner who is primarily interested in making initial sales, and who is inclined to look upon servicing work as a necessary evil, when he should look upon it as a means of establishing more intimate relationship with his customers and creating a firmer foundation for his business.

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210 Power Amplifier and Plate Supply

Easy to build — Simple to install — Economical to operate — Quiet in performance

FULL rich tonal reproduction with a generous supply of power for the heavier tones. You can bring your receiver up to these present standards of reception by building this Thordarson 210 Power Amplifier and B Supply.

Easy to build. Every effort has been made to make assembly as simple as possible. The metal baseboard is equipped with all sockets and binding posts mounted. All necessary screws, nuts and hook-up wire are furnished complete; simple pictorial diagrams are supplied. You can assemble this unit in an hour.

Simple to install. No changes in receiver wiring are necessary. This amplifier can be attached to set in a moment.

Economical to operate. Highly efficient and cool in operation. Consumes less current than a common 50 watt lamp.

Quiet in performance. The reliability of Thordarson engineering assures you of unquestionable performance and quietness in operation.

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GENTLEMEN: Please send me, free of charge, your booklet describing your 210 power amplifier on the metal baseboard.

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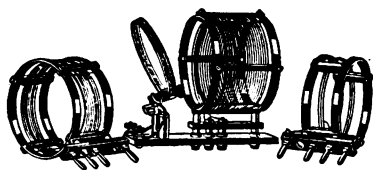
The New TELETROL Uses These AERO Inductances

*You'll want to build it
to enable your present
set to cover short wave
stations*

No single piece of radio apparatus could add more to the value of your present broadcast receiving set than the new Teletrol.

This easily constructed wave lifter enables you to enjoy all the rich amusement offered by 36 different short wave stations—at extremely low cost.

Here are the Aero Inductances used in the Teletrol:



Aero Low Wave Tuner Kit
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Consists of 3 completely interchangeable coils and base mounting. Range 15 to 130 meters. Recognized by amateurs and experts everywhere as the finest short wave kit made. Adopted by U. S. Government and MacMillan and University of Michigan Arctic expeditions.



Aero Oscillator
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Also specified for use in the Teletrol. An exceptionally efficient oscillator.

*You should be able to get
these Aero Coils at your
nearest dealer. If not, order
direct from the factory*

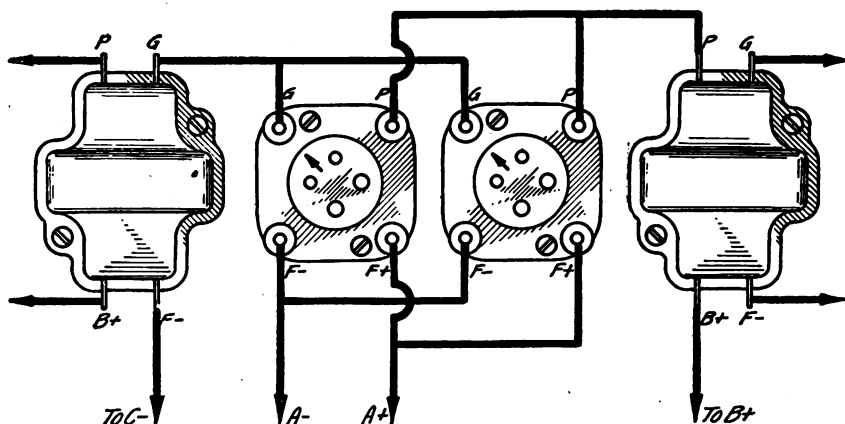
Aero Products, Inc.

Dept. 104

1772 Wilson Ave. Chicago, Ill.

Better Amplification

(Continued from page 233)



DOUBLING UP AMPLIFIER VALVES

FIGURE 5: Here is a simple method of paralleling two standard vacuum valves for obtaining greater power, so that distortion due to overload may be eliminated.

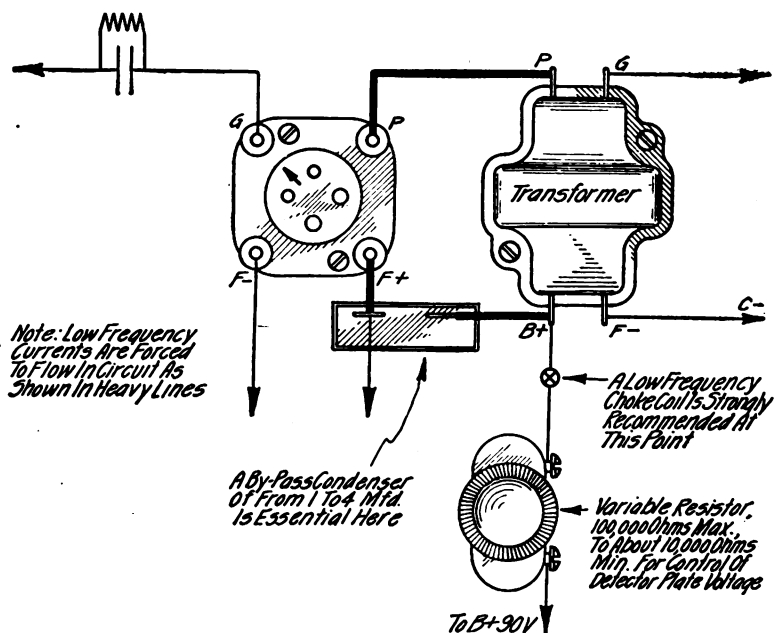
tector of high frequencies, but also as an amplifier of low frequencies. Often operating a UX-200-a valve as a detector with 80 volts on the plate results in much clearer reproduction with only a slight effect on the detector action.

The sensitivity of a set may often be increased very much by the use of a sensitive detector valve. The old UV-200 type valve was such a valve and the Sodian was another. These valves were both noisy. Today two good valves are available, one the UX-200-a type and the other the "Donle-Bristol." These valves are very sensitive and they are not so noisy as their prototypes. For proper results these valves require a

plate voltage control such as that of Figure 6.

A variable resistor is used to adjust the "B" battery voltage. In this case a by-pass condenser is essential to the proper operation of the set. By adjusting the resistor to its maximum resistance, the "B" plate voltage will be a minimum. By adjusting the resistor to its minimum resistance, the detector "B" plate voltage will be at a maximum.

By this scheme the set may be made most sensitive for a weak or distant station. By listening to the station and at the same time starting with a minimum detector plate voltage and grad-



AN EXCELLENT TRANSFORMER CIRCUIT

FIGURE 6: This diagram shows a circuit for a detector that is hooked up to a first stage of low-frequency amplification. The low-frequency currents that produce audible signals must flow from the plate through the primary of the transformer and then directly through the by-pass condenser to the filament circuit without going through the battery leads. This is a great improvement over the older and more familiar hook-up.

ually increasing it until the detector action or signal strength is best, good results may be obtained. Where the signal is strong enough, the resistor may be adjusted to the smallest value. The plate voltage will then be highest and will be best for the quality of amplification. This arrangement works splendidly in the case of "soft" detector valves which are critical to plate voltage adjustment, for by adjusting the resistor, any desired plate voltage may be obtained.

The "C" battery voltage adjustment is exceedingly important. The bias voltage values recommended by the manufacturer of the valve used should be followed. In general, the higher the plate voltage the higher "C" battery voltage, or negative bias.

Everyone who is interested in obtaining the best results from a low-frequency amplifier should carefully and frequently check the "A," "B" and "C" battery voltages by means of a voltmeter; in fact, there is no better sentinel for one's set than a permanently installed "A," "B" and "C" battery voltmeter. Poor or low-voltage batteries cause "grief" in the most excellent sets.

The "C" battery should be varied for the best results and the best value so chosen. In a case where two values of "C" battery voltage seem to do equally well, always choose the more negative value, since it results in "B" battery economy.

Much distortion is introduced when the grid of a valve is not properly biased (negatively), due to the current taken by the grid. A reversed "C" battery will cause a set to be almost inoperative. An improper value of "C" battery will allow the grid to take current for positive halves of the impressed voltage alternation. This effect is known as rectification. This undesired current causes distortion, since it is not proportional to the signal voltage. The proper "C" battery voltage reduces it to a minimum.

To those who have the extra sockets and valves it is often a revelation to take a two-stage amplifier and place an extra tube in parallel between the two transformers and another in parallel with the output valve. For example, two UX-201-a type valves in parallel instead of single one in these two positions may improve the quality of a broadcast program very much in the case of transformer-coupled amplification. This last example is practically the same as using single UX-112 type valves in each stage, since a single UX-112 valve has about the same amplifier characteristics as two UX-201-a type valves in parallel. The wiring arrangement of two sockets in parallel is shown in Figure 5. In the case of dry-battery sets such as those using UX-199 type valves, it may be found advantageous to use two valves in parallel between the low-frequency transformers.



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THE ORIGINAL
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TYPE A



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FOR PLATE
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IMPEDANCE FORMER
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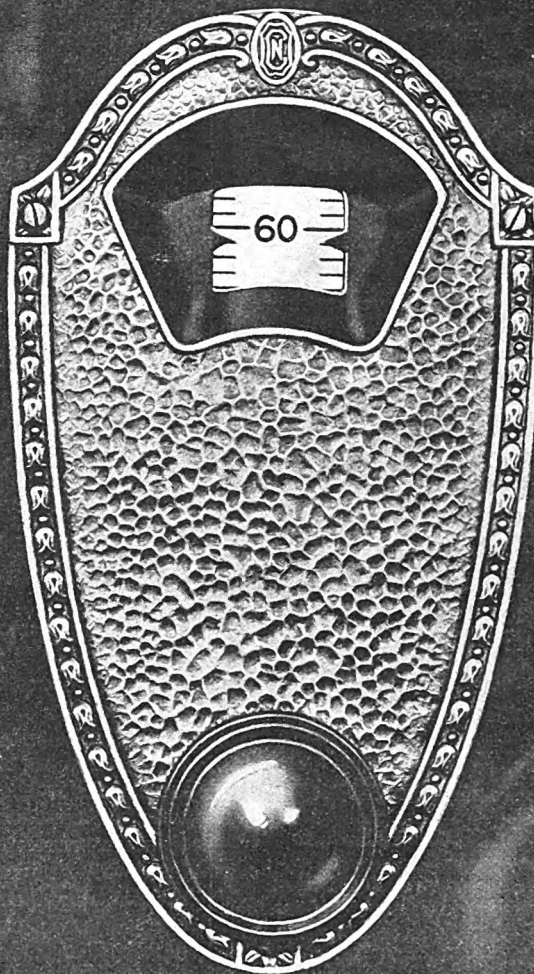
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TYPE 80

Announcing the NEW

NATIONAL

Velvet Vernier Single Drum Dial Type F Illuminated

STATION SELECTOR



FULL SIZE

New in design but with the familiar NATIONAL Qualities—famous Velvet-Vernier Tuning, and made to Use and to last.

360 degrees motion allows attachment to all types of variable condensers.

Smaller Drum, with automatic take-up, permits high position of sub-panel without cutting. Visible portion of dial inclined upward for easier reading.

Easily attached. List price, \$4.00. Type 28 illuminator, 50 cents.

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Resistance-audio has long been known for its fine quality and faithfulness of reproduction.

Held back in the past by poor resistors, it now can come into its own by the use of the TOBE VERITAS RESISTORS. No other resistors are quite like VERITAS. They don't change in values, and stand up day in and day out.

TOBE VERITAS RESISTORS

are used in resistance audio in
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Browning-Drake Radio Sets
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Volney D. Hurd, Radio Editor,
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of Veritas Resistors:

"Resistance Coupling has been retarded due to the inability to stand up under high voltages over any useful period. The development of a new type of Resistor by Stratford Allen, electro-chemist of the Tobe Deutschmann Co., brings this type of Audio into a fixed place in Radio."

Send for literature on TOBE "A" Filter described in this issue of Popular Radio.

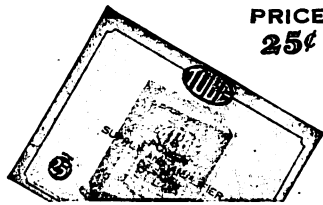


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Gentlemen: Please send me your new book "TOBE B-POWER SUPPLY AND AMPLIFIER DESIGN." Enclosed please find 25c.

Name

Address

Forecasting Static (Continued from page 203)

the thermometer, but fewer persons have an acquaintance with a hygrometer. This instrument, which is made in numerous forms, one of which is illustrated in Figure 1, responds to changes in the moisture content of the air. Many are familiar with toy devices of this sort, such as a girl with a paper dress whose color-changes from day to day forecast the weather. These color-changes are effected by the atmospheric moisture. A good hygrometer furnishes similar information, but much more accurately, and gives us definite figures, usually in percentage, indicative of the amount of moisture the air contains, compared with what it could contain if saturated at the given moment. With the help of thermometer and hygrometer, we can forecast static still more effectively, with the aid of these pointers:

1. If the barometer reads above 30 inches and has been rising during the preceding twelve hours, and if the temperature and relative humidity are falling, static is not likely within the next twelve hours.

2. If the barometer reads below 30 inches and has been falling during the preceding twelve hours, and the temperature and relative humidity are rising, static will prevail during the next twelve hours.

3. If the barometer is constant while the relative humidity falls, static is likely to reduce in intensity if it has been current.

4. If the barometer is constant while the relative humidity rises, static may increase if it has been current.

5. If the relative humidity and temperature remain constant while the barometer rises or falls, a change from the prevailing intensity of static will be effected less quickly than if the relative humidity and temperature changed as indicated in statements (1) and (2).

The reader is cautioned here not to take these statements too literally. They represent merely guides to probable occurrences, and will occasionally be found to be inaccurate, because quite exceptional atmospheric conditions happen from time to time. For example, there are times when the barometer is high, that is, above 30 inches, but begins to fall while the relative humidity rises. It may not yet have reached 30 inches when rain or snow begins, yet static will not make itself known. At all times pressure is the dominant influence, while temperature and relative humidity, if operating according to rules 1 to 2, merely help to strengthen the forecast which the pressure-change indicates.

These last statements call attention to the popular misconception that whenever it rains or snows static will be

prevalent. This is not at all true. The writer has experienced some of the best reception during such storms, but in these instances atmospheric pressure was higher than is customary when rain or snow occurs. On the other hand, much static has been experienced on some clear nights under high pressure conditions, when on these occasions abnormally high relative humidity was accompanied by a sudden drop in temperature. Since these cases are exceptional, although not always rare, perhaps we should not allow them to impress us too strongly.

While we have attempted here to suggest a simple instrumental method enabling the average person to forecast for himself the probability of static, we refer again to the utilization of the daily weather map by those desirous of making a detailed study of the whole problem. The writer has found many relationships between the location of the receiving and sending stations with respect to the extent and intensity of a high or low pressure area, and the probability of static. The details cannot be presented here, but a few major conclusions may be noted. [By way of explanation of the term isobar, the reader is referred to the map in Figure 2, on which he will see concentric lines outlining high and low pressure areas. If these are close together the pressure is intense or strong, but if far apart it is weak. If close together, the pressure area as a unit moves more rapidly than when the isobars are far apart. Any line drawn at right angles across a series of isobars indicates the isobaric gradient.]

Here are some conclusions drawn from a study of these maps:

1. If a line connecting the receiving station with the broadcasting station crosses the intervening isobars at right angles, reception is at its best.

2. The steeper the isobaric gradient (that is, the closer the isobars to each other), the stronger the reception.

3. The more nearly the transmitted waves approach parallelism with the isobars, the weaker the reception. Under these conditions fading occurs.

4. Reception is weaker when the transmitted waves cross from one pressure area into another than when they travel only within one area.

5. Reception is better in winter than in summer because the cyclones (Lows) and anti-cyclones (Highs) are more intense in the winter period.

6. Shallow or flat pressure areas favor much static.

We need more investigation in the field of the relationship of static to atmospheric conditions. Here is an opportunity eminently worth while for both the experimenter and fan.

The ABC of Filament Control

(Continued from page 214)

which employs only two valves, both of the 201-a type. The total current consumption of these two filaments is .5 ampere, and a No. 112 Amperite, a No. 5 Polytrol or a No. 2 Equalizer is the proper unit.

The table given herewith shows the proper filament controls to use for different valves. This table will permit the experimenter to select the proper controls to meet all of his valve requirements and eliminate all his obsolete filament control rheostats.

Where an old receiver is equipped with rheostats, it is a good plan to add controls in series with the rheostats. Thus, if a single 201-a type valve is controlled by a rheostat, a No. 1-A Amperite, a No. 1 Polytrol or a No. 4 Equalizer may be connected in series with the rheostats. The maximum current this control will permit to flow through the filament of this valve is .25 ampere, so it becomes impossible to overload the filament, regardless of how the rheostat is adjusted; yet the rheostat will provide any desired variation downward, as required where the rheostat is used as a volume control, or where the valve it controls is somewhat critical in its filament current adjustment.

The value of this plan is most evident in the fact that it makes the filament current adjustment a fool-proof process, and this is a particularly necessary feature in homes where the receiver is operated by all the members of a family.

Ship to Have Public Radio-telephone Service

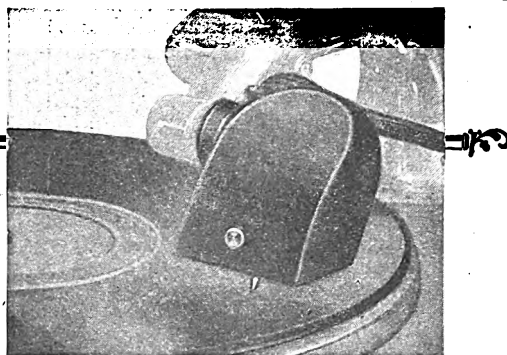
FACILITIES for radiotelephone service from ship to shore will soon be offered to all passengers aboard the Hamburg-American liner *Columbus*, according to *Radiowelt*, a German radio magazine. The new service, which is announced to begin in May, will enable those aboard the ship to sit in the comfort of their cabins and converse with parties in New York or Berlin, as easily as one converses over an ordinary telephone. Only first-class cabins will be equipped with private connections; second and third-class passengers must use the radio room or telephone booths which are provided on the ship.

People on shore will also be able to talk to passengers aboard the vessel. A friend in Berlin picks up his telephone and says: "Please connect me with Mr. X, aboard the *S. S. Columbus*." A while later Mr. X is called from the dining-room to the telephone and hears: "*Achtung, Berlin kommt*" (Berlin on the wire), and the conversation from ship to shore begins.

\$12.50

complete for either A. C. or battery operated sets

NOW—whether your radio is A.C. tube or battery operated—the



PHONOVOX

THE Electric Pick-up

enables you to play Phonograph records **ELECTRICALLY**

THE beauty—the superb tone quality—the wider range of electric phonograph reproduction can now be obtained from your old type phonograph, easily and inexpensively, by simply attaching the Pacent Phonovox to your radio and phonograph.

The Phonovox is made in both the battery and the A.C. models, for sets using the UY227 or CY327 A.C. Tubes. With either type, less than two minutes

are required for attaching, without tools or making any changes in wiring.

Get the thrill and enjoyment of listening to your favorite records played the new way—ELECTRICALLY! Go to your radio or phonograph dealer and ask him to demonstrate the Pacent PHONOVOX. When you have heard it, you will want to own one. Sold and demonstrated by all good dealers.

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Your Radio CABINET



should receive some attention if you wish to preserve or restore its original beauty.

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VARNITE RADIO POLISH

is a scientific compound, designed especially for Radio Cabinets, Phonographs and wherever a superior polish and restorative is required.

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Use VARNITE to clean the panel on your Radio, it will prevent "blooming" and that "foggy" appearance.

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Price: 50 cents

Manufactured and guaranteed by
DAVIS CHEMICAL COMPANY

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Under \$100!

As with the automobile, the best in radio must be CUSTOM-BUILT. But with this remarkable advanced "Hi-Q" Six Receiver you get CUSTOM-BUILT results without paying a CUSTOM-BUILT price.

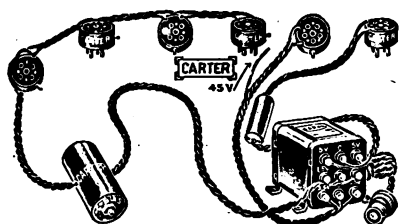
How? The approved "Hi-Q Six" Parts cost only \$95.80—every component is the finest in the industry. Follow our complete 48-page illustrated Constructional Manual and put the parts together. Or have your local Radio-Trician put them together for you.

The result is a receiver that supplies a new standard of sensitivity—knife-like selectivity—utter absence of oscillation—and a quality of tone that is astounding even to experts. Send 25 cents for the Hi-Q Constructional Manual or get a copy from your dealer. Enjoy the ultimate in radio and save at least \$100 over the cost of high class assembled sets. Hammarlund-Roberts Inc., 1182 Broadway, Dept. B, New York City.

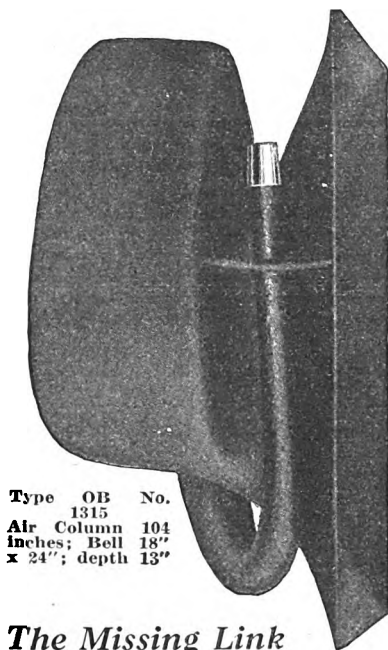
Hammarlund ROBERTS
—Hi-Q SIX—

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Sangamo Elec. Co.	Acme Wire Co. (Parvot)	Radiall Co. (Amperite)
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CARTER**Ready?
Of Course!****CARTER
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A. C. Tube Operation**

Without any structural or wiring change in the set. Change can be made in a few minutes. Complete, eliminates "C" batteries. Write for illustrated folder giving full information.

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CHICAGO**RACON
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Air Column 104
Inches; Bell 18"
x 24"; depth 13"

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For further details address

RACON ELECTRIC COMPANY, Inc.
18-24 Washington Pl. New York, N. Y.

New Results With Crystal Detection

(Continued from page 210)

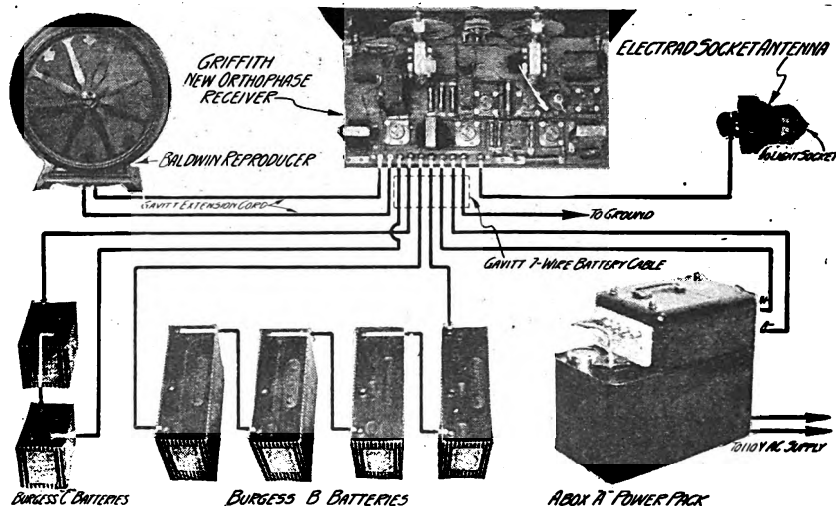
**FOR BEST RESULTS**

FIGURE 4: In the above operating hook-up batteries are used with great success for the supply of the "B" voltages, while an Abox "A" power-pack furnishes the filament current. A standard outdoor antenna may be substituted for the socket antenna.

The composite diagram in Figure 4 shows the proper connections, as well as the recommended accessory apparatus for this receiver.

The next thing to be done is to adjust the phasatrol, which is done as follows: Pull out the battery switch, lighting the filaments; turn the two center knobs (on the panel) to the right as far as they will go, and set the dials at 90 degrees. Now, set condenser, C, so that its plates are half meshed, that is, so that the edge of the rotor plates is at a right angle with the edge of the stator plates. Then, with a screw-driver, turn the screw-head in the phasatrol around in a clockwise direction as far as it will go, which should cause the reproducer to give forth a sound similar to that known as "motor-boating." Then the phasatrol adjustment should be turned back slowly until the noise stops, at which point the phasatrol should be left permanently, as it has been found that this adjustment gives best results.

Now, if it is desired to operate the receiver with controllable regeneration, reset the dials to 100 degrees and turn the screw of condenser V "in" slowly until the noise above referred to reappears. This condenser may now be left in this position, and the oscillation of the set (which is indicated by the noises as above) is controlled by the high-resistance, R.

If it is desired to operate the set without regeneration, reset the two dials to about 50 degrees, and turn the screw of condenser V slowly back until the above noted noise stops; it will now be found that the set will not oscillate at any setting of the panel controls, and the high resistance, R, is used as a volume control.

By noting the settings of condenser

V, it is easy to convert the receiver from an oscillating to a non-oscillating one, or vice versa, at any time.

Tuning the Set

In tuning in a station, the volume control should be at maximum, if the non-oscillating arrangement is used, or if the oscillating setting is employed the volume control should be kept at a point just below that of oscillation.

If a loud hiss is present, it may be eliminated by adjusting the rheostat, Q, which controls the bias of the detector. If it is already in the maximum position (as far to the right as it will go), turn it back slowly until a point is reached where the hiss ceases; a further motion will cause the hiss to reappear. It might be noted here that the silent point is at zero bias, so that turning the rheostat toward maximum applies a current in the conducting direction of the crystal, and turning the rheostat back from the silent point applies a current in the opposite direction to the crystal. It will be found that the most sensitive adjustment will lie between the silent spot and maximum on the rheostat.

The switch, S1, at the left of the panel is for the purpose of short-circuiting the antenna condenser, W1, and is only used in exceptional cases. For average reception the switch is pushed in, and need only be pulled out when receiving weak signals from stations above 60 degrees on the dials; or it may be pulled out at all times if an antenna under 15 feet is used.

It will probably be noted that the selectivity of the receiver is greater when the condenser switch, S1, is pushed in, and the selectivity of the set may be further improved, if necessary, by using a smaller condenser, such as .0005 or .00025 mfd., at W1.

The Individual Tube

Z O

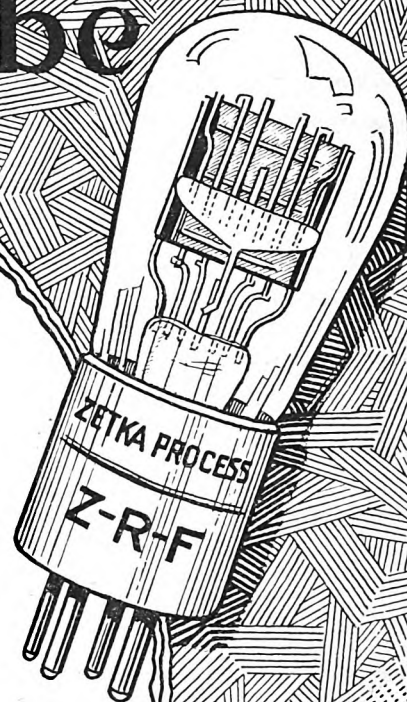
ANOTHER INDIVIDUAL TUBE

A Fit Companion to the New Line of
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A new output tube, developed in our laboratory, to handle the output volume of modern 6 to 10 tube receivers without overloading.

The new ZO tube is a 5-volt, $\frac{1}{2}$ -ampere tube, operating at 180 volts plate with 35 to 40 volts negative grid bias, and is designed to handle the tremendous volume delivered by a full set of Zetka Process Special Duty tubes without distortion.

For push-pull amplification, the ZO, used in both the input and output stages of a push-pull amplifier, will produce an enormous volume with almost unbelievable depth and clarity of tone. Write for details.



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CLEAR GLASS TUBES

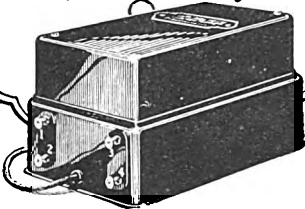
Z-R-F—Radio Frequency Amplifier, 5 volts, $\frac{1}{4}$ amp. High amplification constant. Low plate impedance, and low internal capacity. Uses 90 volts on plate....Price \$4.50

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For automatically switching on and off your B Eliminator and Charger, or either, and in addition, automatically switching off your Charger when the battery is fully charged.

With the Full Automatic Voltage Relay it is now practical to utilize the advantages of a high rate charger, and at the same time control the switching of the charger as well as the B Eliminator with the switch or filament control on the set.

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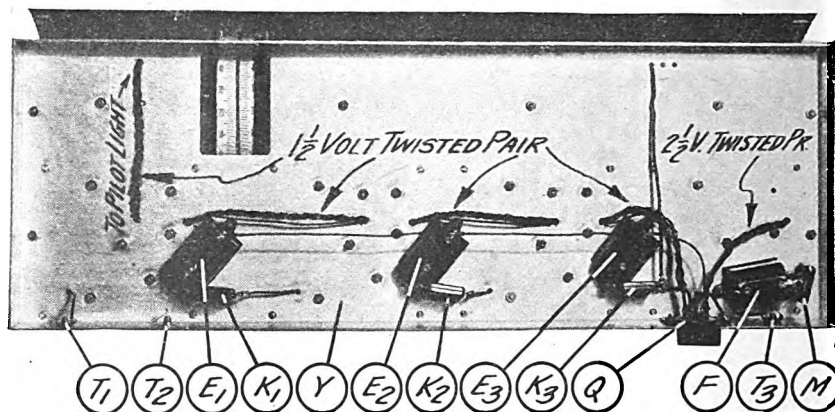
Name

Address

City..... State.....

And Now—An AC LC-28

(Continued from page 200)



THE UNDER SIDE OF THE AC LC-28

FIGURE 5: This view of the new model shows clearly how the twisted cables for the AC filament leads should be run. It is the size of these cables that necessitates the redrilling of the holes in the chassis indicated in Figure 4.

the dial, so that, both binding posts and the dial light are at all times insulated from the metal panel. The switch on the front of the dial is unused. A 1½-volt flashlight lamp is to be substituted for the one that comes packed with the dial.

The connections for the bridge circuits in the filament part of the high-frequency stages are clearly shown in both the schematic and the picture wiring diagrams and no trouble should be experienced at this point.

It will also be noticed that the grid-leak connection, the cathode connection and the filter condenser connection of the detector valve are all made to the chassis, which, of course, is grounded. The output circuit of the detector valve does not go to the cable, as in the earlier model, but is brought out to a separate jack, T3, to be connected to the power-pack amplifier by a separate wire.

After the connections have been com-

pleted it is advisable to check them over with both the wiring diagrams to be sure that no mistakes have been made. When this is done the set is ready to be installed and placed in operation.

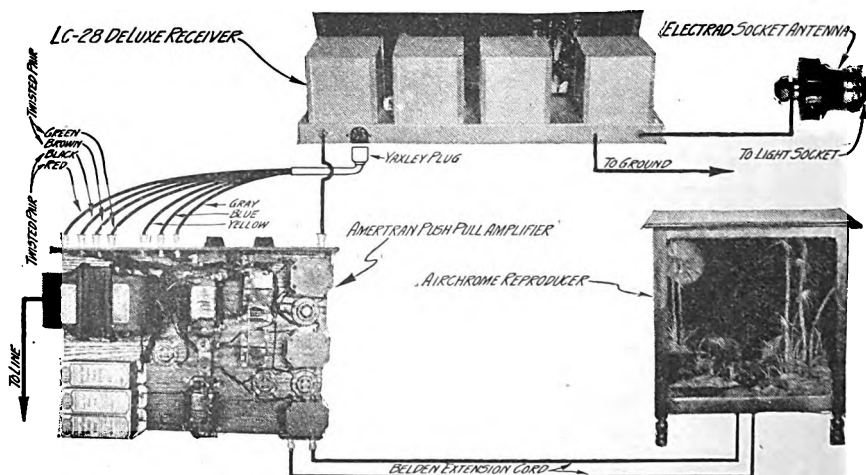
Installing the AC Operated LC-28

The completed LC-28 high-frequency pack may now be placed in the Corbett console, in the top portion of which it is designed to fit snugly.

The power-pack amplifier may then be inserted in the lower portion of the console.

The completed job is shown installed and in operation in the picture on page 198, with the Air-Chrome reproducer alongside of it.

In the photo-diagram in Figure 6 are shown the exact connections to be made between the various units. In this case the AC de luxe receiver is shown connected to the AmerTran push-pull amplifier, the constructional details of which were given in the January, 1928,



THE LAST WORD IN RADIO REPRODUCTION

FIGURE 6: The use of the AmerTran power-pack amplifier and the Air-Chrome balanced-tension reproducer in conjunction with the LC-28 high-frequency pack has given such astonishing results in severe laboratory tests that POPULAR RADIO can recommend it as a radio reception combination that cannot be surpassed.

issue of POPULAR RADIO. The colored wires of the Yaxley cable are to be connected to the binding posts of the push-pull amplifier, as shown in Figure 6. The braided covering of the cable should be cut off and the black and red wires should be twisted together. Then the green and brown wires should be twisted together and finally the complete assembly of wires twisted back into cable form. The diagram also shows the connections from the detector output jack on the high-frequency pack to the single binding post that acts as the input to the push-pull amplifier.

The diagram also shows the ground connection for the receiver and the connection to the light-socket antenna, with which the receiver operates in a very satisfactory manner, without an outdoor antenna. Of course, a regular indoor or outdoor antenna may be used, if so desired. The connection between the Air-Chrome reproducer and the amplifier may be made by means of a standard Belden extension cord, so that the reproducer may be placed on the opposite side of the room.

The power leads from the amplifier are indicated by a line-and-arrow marked "to line" on the diagram. This line should be equipped with an "on" and "off" switch and connected to a light socket of the 110-volt AC lighting lines. The set will then be turned "on" and "off" by means of this switch.

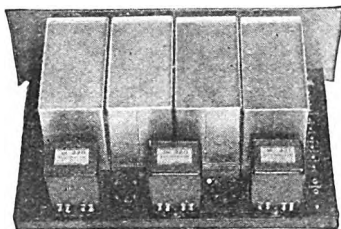
The valves recommended for the receiver are three CX-326 type AC valves in the first three sockets, which are the high-frequency amplifier stages, and one CX-327 type detector valve in the detector stage, in which is located the fourth socket. The valves recommended for use with the AmerTran amplifier were enumerated in the constructional article on the amplifier itself.

It must be remembered that there is approximately a thirty to forty second wait between the time the receiver is turned "on" and the time that it begins to function. This is because of the period required to heat the AC valves to their operating temperature.

If a separate "B" power-pack and a separate low-frequency amplifier are used with the LC-28, it is recommended that a Karas AC-Former be used to supply the AC filament current.

In tests on the new receiver during the last three months the new AC job has demonstrated its ability to reproduce broadcast programs effectively and with fidelity and all in all has proved itself to be considerably in advance of the other models of this receiver. In operation its upkeep is extremely low and requires no service work of any kind to keep in first class working condition. This factor alone makes it an indispensable item for the professional set builder, and its outstanding operation should make it popular with every radio enthusiast.

SM



Use the coupon below for full information
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Shielded Grid Six

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And He Too Was from Missouri!

ONCE upon a time—to make a long story short, a man living in Missouri didn't believe—he had to be shown. So he bought a 630 SG Shielded Grid Kit. The first night he listened to WEA, New York, and KFI, Los Angeles, and he had about thirty-five more—near and far. Then one morning at about 5:00 A. M. he tuned in KGU in Honolulu and he lived happily ever after.

That is the story of not one but literally hundreds of owners of the new Shielded Grid Six. The set is absolutely so good that there is practically nothing like it. Coast to coast with a small loop or a 15-foot indoor antenna, under average conditions is regular performance. Japan and Australia fairly regularly on the west coast; east and west coasts, Canada, Cuba and Mexico from Illinois—these are the reports that pour in day after day. The Shielded Grid Sixes are easy to tune—only two dials—no repeat points—no wide spreads on locals—tonal beauty that is startling in its natural reproduction. They're the closest to the "Ideal" set you'll hear for many a day to come.

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You can easily sell them your spare hours for \$3 each by serving as "radio doctor," building them sets, selling them supplies at less than retail. A membership in the Association shows you how to cash in on Radio now and trains you for the \$3,000 to \$10,000 openings awaiting qualified men. The Association starts you in business if you wish. Investigate all it has done for others, all it can do for you. A MEMBERSHIP NEED NOT COST YOU A CENT.

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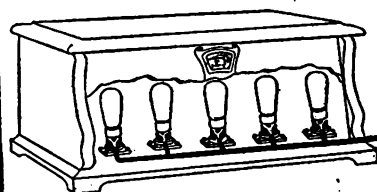
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AEROVOX
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because they are
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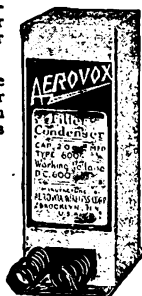
TEST—TEST—TEST, and then again more tests. Raw Material tests, for conductivity, resistivity and dielectric qualities. Ten tests of each condenser during manufacture. Comparative tests and Life Tests after completion. Absolute perfection, or instant rejection.

That is why eminent engineers are using Aerovox fixed condensers. Their long experience and training teach them how to tell whether condensers are "built better."

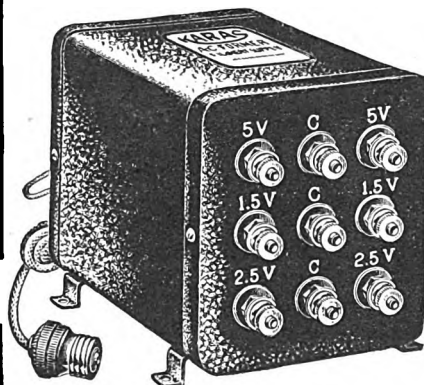
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KARAS



A-C-FORMER
for the
L-C-28

The KARAS A-C-FORMER is suggested to supply the correct filament voltage for the AC tubes in the L-C-28 circuit... another tribute to its recognized high quality!

CONVERT TO AC
—and use the KARAS A-C-Former when you convert your battery operated set to AC operation, in conjunction with Carter, Eby and other cable harnesses, for 4, 5, 6 or 7 tube receivers.

TYPE 12

Supplies up to 8—226, 2—227, and 2—171 type tubes

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List Price

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In the Professional Set Builder's Shop

Practical pointers and kinks to increase efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, aided by a well-equipped Laboratory, will find it and present the details to our readers in a practical and concise manner.

The Service Man's Tool Kit

If professional set builders are to be successful in building up their clientele, they must live down the bad reputation established by plumbers, who always seem to be minus some important tool when they are making repairs. To help radio repairmen to solve this problem, the Laboratory of POPULAR RADIO has assembled what it believes to be the ideal tool kit—a kit that will meet practically every emergency that repairmen may have to solve. The ideal repair kit should contain not only hand tools, but a few spare parts as well, so that emergency repairs may be made in urgent cases.

The outfit shown in Figure 1 is complete in practically every detail and small enough to be easily carried in a Boston bag. The more rugged mate-

rial is fitted into the bottom of the bag, while there is sufficient room left on the top so that the meters can be placed in a position where they will not be damaged.

This ideal tool kit contains the following items:

- 1 soldering iron with holder;
- 1 8-inch round file;
- 1 counter sink;
- 1 square (6 inches);
- 1 scriber;
- 1 automatic center punch;
- 1 6-inch ratchet screw-driver;
- 1 8-inch ratchet screw-driver;
- 1 small compass;
- 1 pair side cutting pliers;
- 1 pair flat-nose pliers;
- 1 8-inch round brush;
- 1 folding rule;
- 3 drills (3/4 inch, Nos. 28 and 31);
- 1 hand drill;
- 1 0-15 volt AC voltmeter;



THE RADIO "FIRST AID" KIT

FIGURE 1: With the testing equipment and spare parts shown above, which may be conveniently carried in a Boston bag, the service man can take care of most of the emergencies that he is likely to encounter; or, if a serious breakdown has occurred, he can ascertain the approximate nature of the trouble.

- 1 0-50 milliammeter (DC);
- 1 0-600 high-resistance voltmeter (1,000 ohms per volt);
- 1 pair 2,000-ohm phones;
- 4 small fixed condensers;
- 3 by-pass condensers;
- 6 grid-leaks (miscellaneous values);
- 1 filter condenser (2 mfd.);
- 1 roll solder;
- 1 roll friction tape;
- 1 jack knife;
- 20 feet connection wire (flexible);
- 6 testing wires with clips;
- 1 hydrometer;
- 1 Boston bag.

The price of this model kit will depend somewhat upon the quality of the tools and meters used. While good meters are recommended, the beginner can probably struggle along with less expensive ones. In outside work, the most important thing is to establish the source of trouble, and a meter does not have to be extremely accurate, since a rough estimate of the voltage or output current is usually sufficient as a check-up. It will be noticed that small condensers and filter condensers are included. With modern high-power amplifying equipment, it often happens that condensers are ruptured. In such instances, a second trip can easily be saved if the repairman has the necessary replacement parts in his kit.

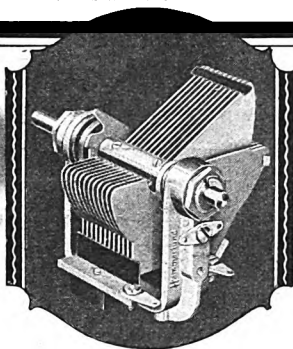
The kit described can be made still more complete by the addition of one of each of the popular types of vacuum valves used. For instance, one 201-a, one 171, one 112, one 226 and one 227. Also one Raytheon rectifier valve would prove extremely valuable in cases where defective rectifier valves are encountered.

One of the most important items in the kit shown above is a set of flexible connector wires provided with spring clips. With these clips temporary connections may be made quickly, which is a great asset in checking up troublesome circuits, and in applying meters for current measurement and open-circuit tests.

Controlling Oscillation in High-Frequency Circuits

THE potentiometer method of stabilizing the usual high-frequency amplifier, in which the grid return is varied so that a variable positive potential may be placed on the grid, is not the best method, according to many radio authorities. The chief objection is the heavy plate current taken by the valve when the grid is positive. A more satisfactory and certainly more efficient method now coming into wide favor is to insert a precise variable resistance, such as the volume control Clarostat, in the "B" positive (+) lead of the amplifier valve, thus lowering the effective plate voltage. This method has other advantageous features, one being the saving in "B" current effected.

—IRVING CALKINS



HAMMARLUND
"Midline"
CONDENSER

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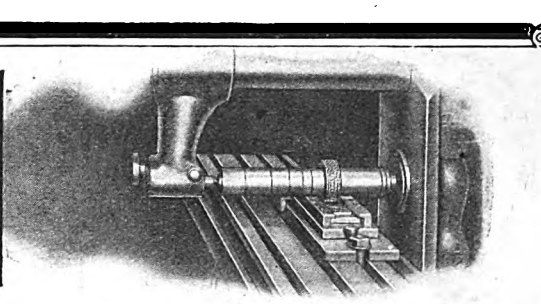
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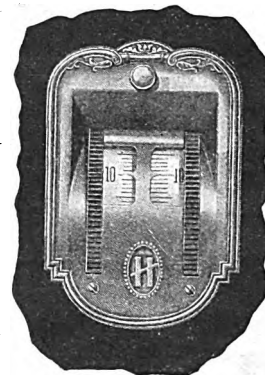


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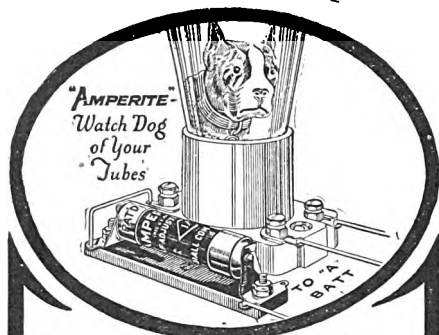
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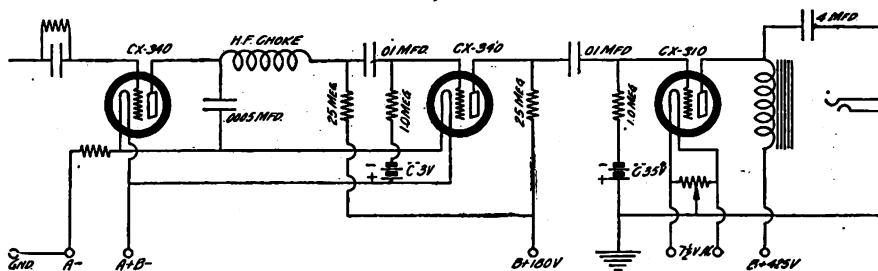
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A SIMPLE RESISTANCE-COUPLED HOOK-UP

FIGURE 2: With high- μ valves in the detector stage at the left and the two low-frequency stages, this resistance-coupled amplifier will give all the volume necessary for home use.

More Data on Resistance Coupling

WITH the advent of better high-vacuum valves, reliable resistors and high-voltage socket-power operation, the resistance-coupled method of amplification has once more come into its own as a means of obtaining excellent tone quality, together with ample volume, at low cost.

In the first place, the all-important thing with resistance coupling is to employ high-mu amplifying valves. Today there are several makes available for this very purpose, such as the Ceco or CX-340, with a mu or amplification constant of from 20 to 30, as compared with about 8 for the standard type of valve.

The second consideration is the use of proper resistances, not only in the matter of correct values, but particularly in stability of operation. Resistance coupling is particularly susceptible to changes in resistance which alter the results and sometimes introduce serious noises. For this reason it is essential to employ high-grade resistors which are capable of providing accurate and lasting resistance values, even when handling considerable currents, without the danger of resistance changes causing noises.

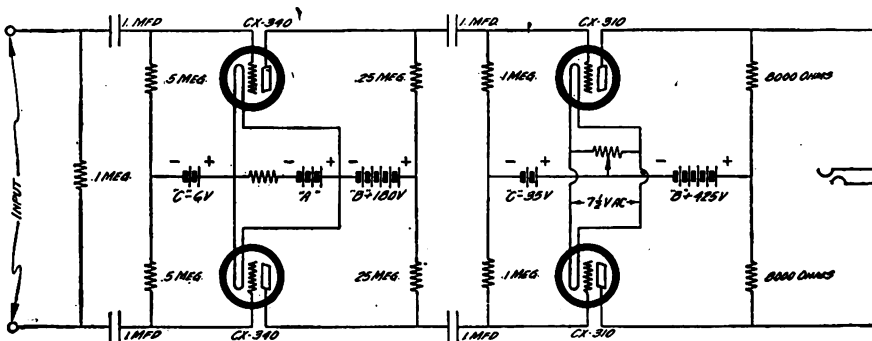
The third consideration, and one of great importance, is to have sufficient plate voltage available. It is generally overlooked in resistance coupling that the plate voltage impressed on the plates of the vacuum valves must pass through the plate-coupling resistors, the value

of which is usually 100,000 ohms or more. In the case of the high-mu valves, the plate-coupling resistor is 250,000 ohms. Obviously, to overcome this high resistance in the circuit and still have sufficient voltage to operate the valve efficiently, it is necessary to start out with sufficient voltage, preferably 180 volts, on the plate-coupling resistor—that is, the maximum voltage tap of the usual “B” power-pack. If “B” batteries are employed, there should be four blocks of 45 volts each.

The ideal resistance-coupled amplifier, using present-day components, is shown in Figure 2. It will be noted that, due to the high-mu valves now available, the three-stage amplifier is no longer required, provided a high-mu detector is employed. Also, it will be noted that an output filter is employed, preferably in the form of a choke coil and series condenser, so as not to introduce distortion and also in order to keep the direct current out of the reproducer.

The resistance values here given are based on tests, and do not run as high, in the case of the grid-leaks, as those generally specified for the present high-mu valves. While there is a slight loss in volume, which is certainly not noticeable, there is better assurance of ample grid-leakage so as to avoid any possibility of "blocking" or the piling up of successive signals.

The layout shown in Figure 2, comprising a high- μ valve for the de-



RESISTANCE COUPLING IN A PUSH-PULL AMPLIFIER

FIGURE 3: *With the hook-up shown above it is possible to achieve astounding volume and clarity, and the compactness of the unit recommends it additionally to those seeking the best in power-operated, low-frequency amplification.*

detector and for the first stage, and a 171 or 210 type of power valve for the second stage, will provide as much volume as the usual transformer-coupled amplifier, with excellent tone quality.

The use of a high-mu detector valve serves to obtain considerable amplification, as well as signal rectification. A 3-megohm Durham metallized resistor may be employed for the detector grid-leak, in combination with a .00025 mfd. grid condenser.

For those seeking enormous volume together with a remarkable depth and detail, resistance coupling presents many interesting possibilities in conjunction with present-day high-voltage socket-power operation. In Figure 3 an interesting development in the way of a powerful push-pull amplifier with excellent tone quality is shown. Indeed, this amplifier provides the volume of a small orchestra.

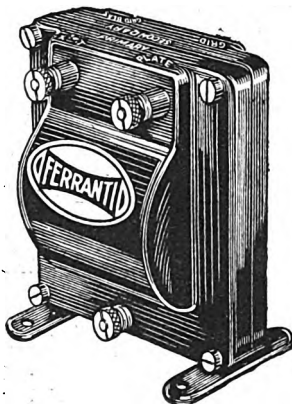
The diagram is virtually self-explanatory. All resistors employed are of the metallized resistor type, of the values indicated in megohms, except where they are followed by the "ohm" sign. However, it is best to use 2½-watt "power-ohms" for the 8,000-ohm resistors employed in coupling the output with the reproducer, in order to handle the considerable current without material change of resistance value. Because of the power handled with this amplifier, none other but reliable resistors should be employed. It will be noted that the plate current must be supplied by a "B" power-pack capable of supplying 425 volts for the 210 valve supply, while the filaments of these large valves operate on 7½ volts raw alternating current. One 216-b type rectifier valve will be rather heavily taxed if made to supply two 210 power valves, and the plate voltage is apt to drop down below the necessary value for operating these valves at the proper efficiency. A 281 rectifier, substituted for the usual 216-b, will help out in this connection. However, for best results the "B" power-pack should have two 216-b or 281 rectifiers arranged for full-wave rectification; such a hook-up will supply ample plate voltage and current for the operation of two 210 power valves.

By changing the "C" battery to 45 volts and the plate voltage to 200 volts, with output plate resistors of 5,000 ohms each, good results will be obtained with two 171 type valves in place of the 210's for those who must operate on "B" batteries.

Incidentally, in Figure 3 we have not indicated the filament supply current, but it goes without saying that the first stage valves are of the high-mu type, while the two power valves are operated on 7½ volts, if the 210 type valves are used, and 5 volts, if the 171 type valves are used.

—F. R. EHLE

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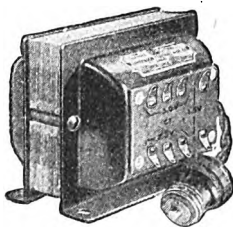
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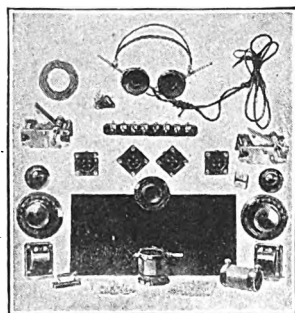


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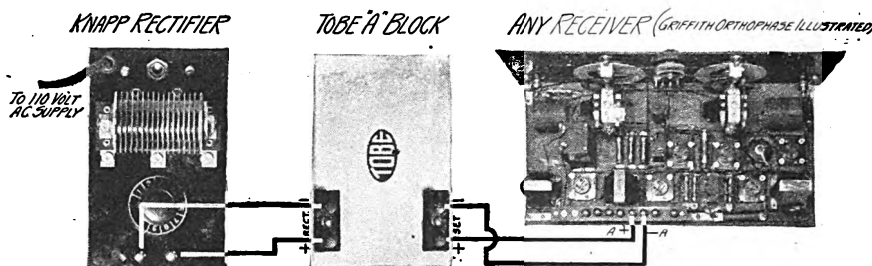
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Dry "A" Power from the Socket

(Continued from page 228)



HOW TO INSTALL THE "A" POWER UNIT

FIGURE 3: The connections between the rectifier unit, the filter unit and the receiver with which the "A" power-pack is used are shown here in heavy black lines.

circuit of any standard set by following the photo-diagram in Figure 3. Note that binding post H1 is positive (+) and H2 is negative (-). It will also be noticed that two wires go from the output binding posts, H1 and H2, of the rectifier unit to corresponding binding posts on the filter unit, and two more wires from the filter unit go directly to the "A" circuit of the receiver with which the "A" power-pack is to be used. The switch, C, on the rectifier unit should be rotated until the correct filament voltage is obtained for the number of vacuum valves utilized in the

receiver. This had best be done with a voltmeter and when once determined needs no further adjustment.

The operation of the new unit will be found to be silent and steady; and, as there are no liquids in the unit, no servicing is necessary outside of an initial adjustment of the switch, C. The complete "A" power unit can be placed in the lower portion of the console and left without further consideration.

The life of the unit should be indefinite, as there is nothing to wear out and no moving parts that need servicing or replacement.

Radio Luxury in Power Units

(Continued from page 226)

fastened to the apex of the cone that carries the low-frequency currents. Because of the small size of the cone used, and because of its almost unlimited freedom to move to and fro, the new reproducer must be mounted upon a suitable baffle board for reproducing the extremely low frequencies which the amplifier is capable of producing. In nearly all cases this baffle board may be the front of a console or cabinet in which the speaker is mounted; or, again, it may be the wall of a room.

The general appearance of the complete amplifier is shown in Figure 2. It is completely mounted on a wooden baseboard and is so simple in construction and wiring that anyone may complete the job satisfactorily in an hour's time.

How to Construct the Power-Pack Amplifier

It is best to start by mounting the transformer, A, the condenser, C, and the choke coil, B, alongside of each other on the baseboard, as shown in Figure 2, and in the picture wiring diagram in Figure 3. Be sure that they are turned in the directions indicated in these illustrations.

Next mount the three transformers, D, E and F, in a similar manner, as well as the six sockets, L1, L2, L3, L4,

L5 and L6. These are screwed to the baseboard with ordinary brass wood screws.

Next mount the binding posts, M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11 and M12, as indicated in Figure 3, on the connection panel, O, and fasten the connection panel to the baseboard, N, by wood screws inserted through the panel and into the edge of the baseboard.

Next mount the resistors, G, H, I, J and K, on the resistor mounting panel, P, in the relative positions shown in Figure 2. The resistor mounting panel should then itself be mounted by means of small brass brackets, according to the instructions given in the illustrations. The set is now ready to be wired up.

In making the connections on the new unit, it is advised that the constructor follow exactly the details and wiring given in the picture wiring diagram in Figure 3. In this drawing the various panels, the baseboard and the instruments themselves are outlined in black lines, while the connecting wires are designated by heavy red lines. Follow out these connections explicitly and no mistakes will be made.

It is recommended that an insulated wire, such as Corwico rubber-covered hook-up wire, be used for this purpose.

After the complete connections have been made, it is advisable to check them over, to be sure that they are all correctly connected and that there have been no omissions.

How to Install and Operate the Amplifier and Reproducer

First of all, the set with which the amplifier is to be used should be installed in its cabinet and then the amplifier itself may be placed in the lower portion of the console or in the radio table.

In Figure 1 is a photo-diagram showing the connections between the LC-28 high-frequency pack and the amplifier.

Of course, any receiver including a high-frequency amplifier and detector may be used with the power-pack. The connections in the illustrations show exactly how the amplifier is to be hooked up to the set, as well as to the Magnavox reproducer. Notice that four wires run to the reproducer, two of which are for the field winding and two are for the moving-coil winding.

Standard vacuum valves are used and the following are recommended: Two 381 type valves in sockets L1 and L2, a standard 374 type regulator valve in socket L3, a 301-a type valve in socket L4, and two 310 type valves in sockets L5 and L6.

The reproducer may be installed and attached to the inside of the radio cabinet, with a hole cut in the cabinet slightly smaller than the periphery of the cone. A suitable grill work may be fastened on the outside for decoration. The cabinet itself will then act as a baffle board. Or a deep hole may be cut directly in one of the walls of the room and the reproducer may be installed in it with a decorated covering. In this case the wall itself will act as the baffle. This last idea gives exceptionally fine results and produces low tones with true volume and realism.

The voltage adjustment may be made with the variable resistor, H, on the power-pack until the correct conditions are obtained throughout. In making this adjustment, it is recommended that a high-resistance voltmeter with a scale reading of zero to 600 volts be utilized. The adjustment should be made with the set and the power-pack amplifier in operation and when once adjusted will need no further attention.

With this apparatus a new receiver may be built for giving exceptionally large volume and improved tone quality, or an old receiver may be improved. The power-pack amplifier furnishes complete "B" voltages for the receiver with which it is to be used and a suitable "A" power-pack used in connection with both will give complete operation from the AC lighting lines, except for a small "C" battery upon which there is so slight a drain that its working life is almost equal to its shelf life.

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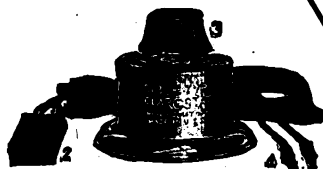
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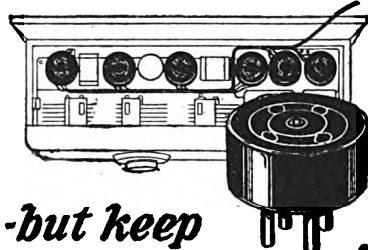
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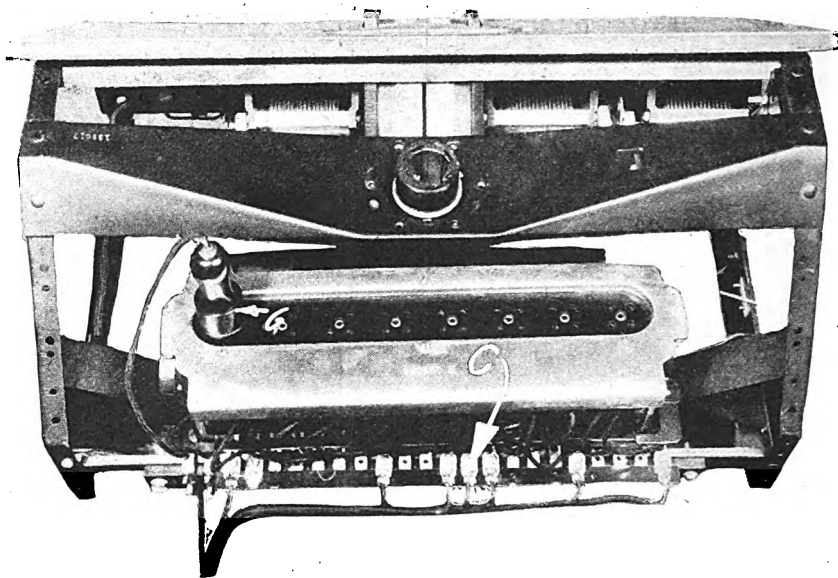
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Put This Power Box in Your Radiola 28

(Continued from page 201)



THE INSTALLATION OF THE RESISTANCE STRIP

FIGURE 1: The receiving unit proper of the Radiola 28 is here shown clear of the cabinet, in order to make plain the installation of the resistance strip, C, and the transfer plug, G.

Changes in the Receiver Unit

In the rear of the socket strip, and slightly underneath, will be found a connection strip that is fastened to the receiver unit with 19 screws. Loosen these and slide the connection strip out at the end, without damaging adjacent wiring.

Then substitute the resistance strip, E, that is supplied with the new AC apparatus. Place this resistance strip so that its terminals are in line with the original screw holes and fasten them all back again so that the new strip is held in the place where the old one originally was.

Next remove the wire-wound resistance rods from the "battery-setting" and rheostat and replace it with one of the new rods marked "F" in Figure 3. Be sure that the rod is turned so that the contact arm rubs on the bare portion of the winding.

Next take out the remaining resistance rod from the "volume-control" rheostat and replace it with the remaining new rod "F." The contact arm of the volume-control rheostat will be found to be connected by a flexible spring to one of the metal brackets supporting its resistance cartridge. This spring should be reconnected to the bracket located nearer the outside edge of the wooden panel. This will reverse the volume control so that it will work in the right direction.

Next unsolder one of the two leads connected to the filament switch and reconnect it to the same prong that the other lead is connected on.

Remove the leads connected to the voltmeter clip, solder them together and tape up the ends. Connect this volt-

meter clip to the bracket on the nearer side of the volume-control rheostat with a piece of insulated wire. Do not touch the connections to the voltmeter clip that are on the side near the volume control rheostat.

Changes in the Cabinet

First lift out the battery pan, bending the two ends "inward" and then bending "in" the back of the pan, using a screw driver underneath the cabinet to pry it loose, if necessary. Then fasten in the two brackets, H, in place of the battery pan, placing them about six inches from each end of the cabinet. Now install the condenser unit, B, in place in the right-hand front portion of the battery compartment, using four screws to fasten the brackets to the floor and to the front side of the cabinet.

Replacing of the Unit

Close the upper compartment and insert the panel so that it sticks out about three inches. Connect the terminal strip of the seven-wire cable, C, to the receiver terminal board. The cable terminals should be lined up with the receiver terminals so that the yellow lead with the red tracer connects with the terminal at the extreme left. Then tightly secure all screws on the terminal board and especially the eight screws fastened to the cable terminals. Now push the other end of the cable down through the hole at the back of the cabinet and slide the complete receiver into the cabinet and close the lid. Open up the battery compartment and replace the four screws and washers which fasten the receiver unit securely into the upper portion of the cabinet.

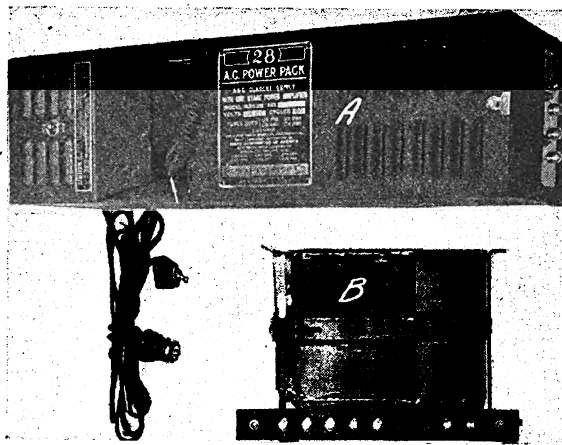


FIGURE 2: THE POWER AND CONDENSER UNITS

The next job is to connect the four-wire cable to the terminal board on one end of the power unit, making sure that the markings on the metal tags agree with the markings on the panel. Now place the power unit, A, in position in the brackets in the lower cabinet. Next connect the leads of both the seven-wire cable from the receiver terminal board and the leads from the four-wire cable of the power unit terminal board to the terminal strip of the condenser unit, being sure that the markings on the metal tags on each cable lead agree with the markings on the condenser terminal board. Next connect the reproducer to the power unit terminal board.

The single wire brought out at the top of the power unit near the valves should pass up through the same hole in the bottom of the set through which the seven-wire cable passes. Insert the transfer plug, G, in the valve socket No. 8 at the extreme right, in which the power valve is usually used, and insert the tip of the single wire into the top of the transfer plugs. Next insert the CX-310 type power valve at the rear of the new power unit and insert the CX-380 type valve at the front. This allows the last stage of amplification to be obtained through the CX-310 type power valve in the new power unit.

It will be noticed that a small switch is connected in the power-supply cord. This switch should be mounted at any

convenient point on the under side of the cabinet by means of wood screws, so that it can be easily turned "on" and "off." Insert the seven original CX-299 type valves in the sockets Nos. 1, 2, 3, 4, 5, 6 and 7, then close the lid of the cabinet and reinsert the loop. The attachment plug on the power-supply unit should be placed in a lamp socket near by.

Operation of the Unit

It is only necessary to turn the light socket switch "on" or "off" to place the set "in" or "out" of operation.

The operation of the receiver will be now identical with the battery-operated job, except for the following details:

1. The original filament switch is not used to turn the set "on" and "off."
2. The battery-setting rheostat will not turn the current "on" and "off."

This rheostat should be set at a minimum value consistent with good quality reproduction.

There is a toggle switch marked "high" and "low" mounted on top of the power unit. This is designed to take care of variations in the lighting line voltages. For voltages of 105 to 115 volts, this switch should be set at "low," and for voltages of 115 to 125 volts the switch should be set at "high."

The set should now function for a long period of time without any fuss or bother with batteries, as it will be operated solely from the lighting lines.

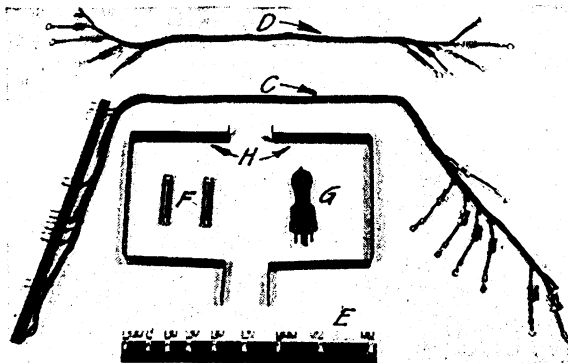


FIGURE 3: THE ACCESSORY APPARATUS

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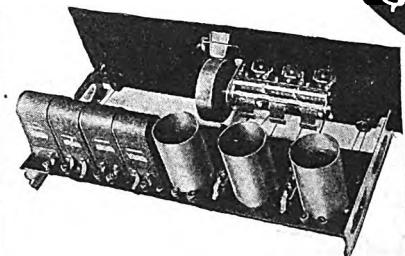
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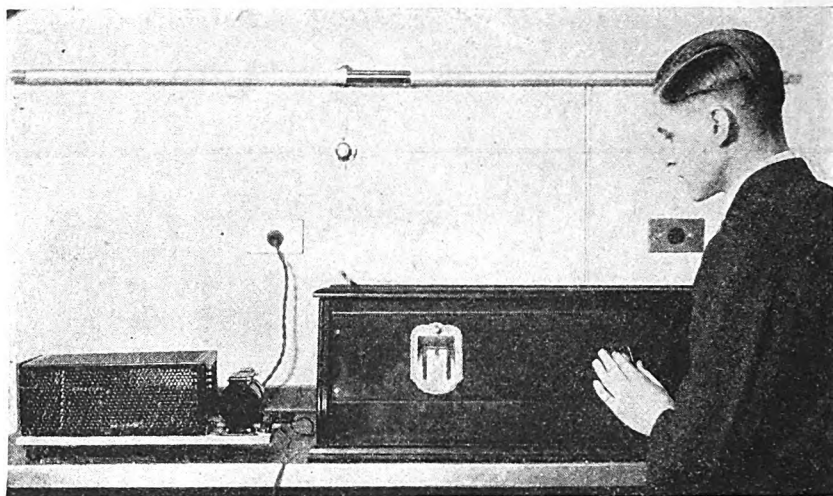
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Radio RTM Service

A DC Socket-Operated Amplifier

(Continued from page 212)



THE UNIT IN OPERATION

FIGURE 4: This view shows the unit in operation with the LC-28 high-frequency pack. The perforated metal cover protects the user from contact with the hot or live parts of the unit, and prevents the withdrawal of any of the valves while the apparatus is operating.

one or more be removed while the unit is operating, damage to the remaining valves is possible, due to overload.

The unit embodies two line fuses at the input from the light socket to prevent damage in case of short circuit in the amplifier.

In all direct current units a certain amount of heat must be dissipated. A heat baffle plate of transite is used in this unit to separate the heat-dissipating resistors from the remainder of the assembly, and at the same time to force the heat rapidly upwards and out of the unit. As a matter of fact, the heat will not be found in any way troublesome or excessive, but it is always well to provide for a quick and effective dissipation of such heat as may be generated in any DC unit.

How to Construct the Amplifier

First drill the panel, P, for the battery-charging meter, M, the battery switch, S, and for the mounting holes in each lower corner. Then fasten down the meter and switch in position.

Next place the remaining parts for the amplifier in their correct positions, as shown in Figures 2 and 3, and mark the location of the mounting holes of each instrument on the transite base, R, either with a pencil or a scratch awl. Then remove all the instruments and drill the required number of holes in the transite base.

First fasten the wooden feet, T1, T2, T3 and T4, underneath the base and fasten the mounting brackets, U1, U2, U3 and U4, in position above these feet with machine screws through the base. It may be noted that all the parts are mounted with brass machine screws and nuts.

Then fix the fuses, N1 and N2, in place under the transite base.

Next mount the sockets, H1, H2, H3, H4 and H5. Sockets H1 and H2 have the plate and grid terminals towards the near edge of the base. Sockets H3 and H4 have their filament terminals towards those of the sockets just mounted. Socket H5 has the filament terminals towards the near edge of the base.

Fasten the automatic filament control, I, near socket H5 and fasten the filament control, J, in position on the opposite side of the base.

Place the 1 mfd. condenser, E, on top of the 2 mfd. condenser, F, and fasten them to the base. Two terminals of these condensers are connected together and a drop of solder on the opposite side will hold the top condenser in position. Then fasten the 4 mfd. condenser, G, in place.

Mount the low-frequency transformer, A, with the plate and "B" positive (+) terminals towards the near edge of the base. Mount the input push-pull transformer, B, with the three terminals towards the sockets and the output push-pull transformer, C, with the three terminals also towards the sockets.

Place the choke, D, in position with the terminals away from the near edge of the base and fasten it down.

To mount the 250-ohm resistors, L1, L2 and L3, place a mounting washer on a stove bolt of the proper length and run the bolt through the center of the resistor and through the base and fasten with a nut. Mount the 8-ohm mid-tap resistor, K, in the same manner.

Place the heat baffle between the resistors and the main part of the amplifier and fasten it to the base with the small brackets, V1 and V2.

Mount the panel, P, on the small

angle brackets, U1 and U2. Fasten the input binding posts, O1 and O2, adjacent to transformer A and the output binding posts, O3 and O4, on the opposite side of the base.

How to Wire the Amplifier

A type of wire such as Corwico braidite should be used in connecting up this amplifier, which must be wired exactly according to the picture wiring diagram in Figure 3.

It is suggested that the power circuit from the fuses to the filaments of the amplifier valves be wired up first. Then the "B" supply circuit, or filter circuit, can be connected. After this is finished the plate and grid terminal connections can easily be made.

A cable of two-conductor flexible wire should be run from the unconnected ends of the fuses to an attachment plug at the nearest light socket.

How to Install the Amplifier with the LC-28 Receiver

Refer to the photo-diagram in Figure 1 for the complete connections of the installation. Connect the red and black terminals of the Yaxley plug to the positive and negative terminals of the Exide "A" battery, as usual. Connect the yellow, blue and gray terminals to the negative, "B" positive (+) 45 and "B" positive (+) 90 terminals, respectively, of the Burgess "B" batteries. These batteries supply the high-frequency part of the circuit, the LC-28 receiver. Connect the green and brown wires from the Yaxley cable to the plate and "B" positive (+) terminals of the first stage transformer, A, of the DC-operated amplifier. Connect the output binding posts of the new amplifier, O3 and O4, to a quality reproducer, such as the Racon horn.

Insert an Electrad socket antenna in a nearby electric light socket and connect to the antenna binding post of the LC-28 receiver. Ground the receiver on a water pipe.

Insert a CX-301-a valve in socket H5 and a CX-171-a valve in each of the sockets H1, H2, H3 and H4.

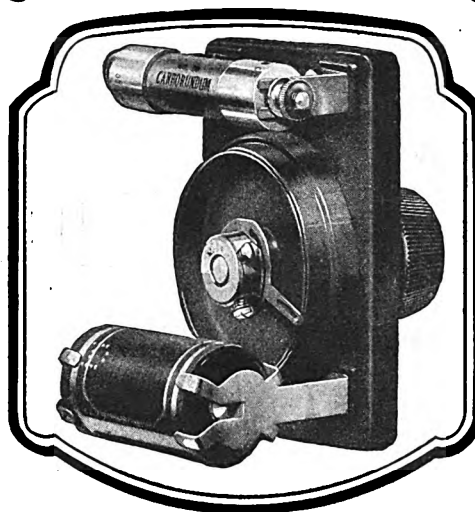
Fasten the perforated metal cover, W, in place.

Operating the Amplifier

On the front panel of the assembly is the polarity indicating meter to give a quick check on the polarity of the plug in the light socket or wall outlet. When the unit is first tried, the polarity of the plug may be incorrect and the amplifier will not function. Reverse the position of the prongs of the plug in the receptacle. Once the correct position of the prongs is found, note the reading of the indicating meter on the front panel. Then you can always tell when the plug is in the right position in the DC outlet.

The "on-off" snap switch on the front panel controls the entire unit.

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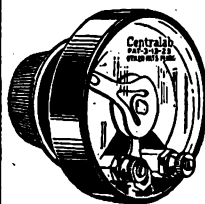
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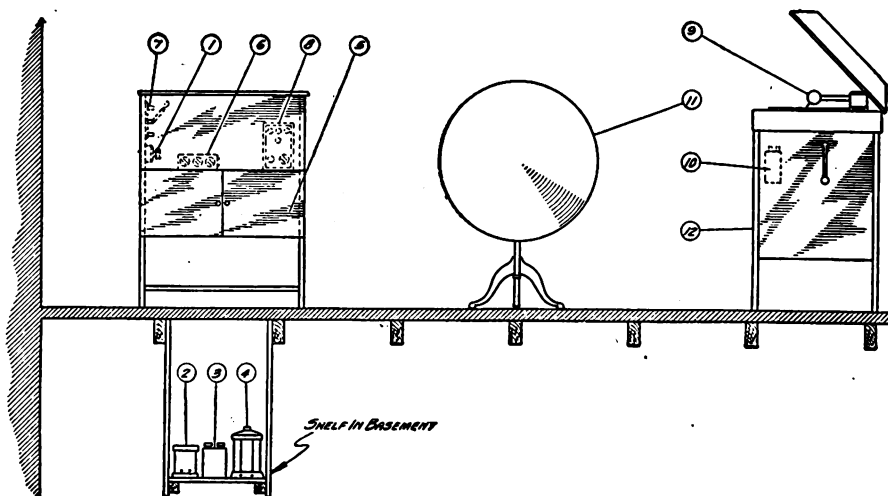
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Listening In

(Continued from page 230)



THE ARRANGEMENT OF THE INSTRUMENTS

FIGURE 2: The numbers in the diagram correspond to the list of parts in the text. As the diagram shows, there is no necessity for unsightly exposed wiring or instruments.

The battery charger will only function when the five-pole switch is thrown to the receiver side, the switch on the receiver is thrown to the "off" position, and the snap switch, No. 1, is turned "on." The five-pole switch should therefore always be left set on the "receiver" side except when the phonograph is being used. Then, when it is desired to charge the battery it is only necessary to turn "on" switch No. 1; or, if a trickle charger is used, this switch may be left "on" all the time, or may even be eliminated entirely. This will leave the battery on charge at a slow rate during the time that the receiver is not in use.

—C. C. CLARKE, Iowa Falls, Iowa.

* *

How One Reader Safeguards His Vacuum Valves

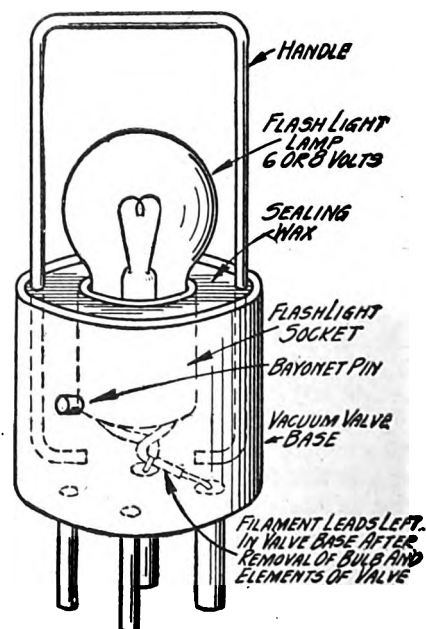
In connection with my experimental work I have devised a small device which can be made by any fan at practically no cost, and which safeguards vacuum valves against burning out in case the "B" battery should be incorrectly connected across the filament terminals, or in case a short circuit should develop between the high voltage side of the "B" battery and one side of the "A" battery.

Before the valves are inserted in their sockets in a new set, but after the batteries have been connected, this "valve saver" should be placed in each of the sockets in turn. If the filament circuits are properly wired and the "A" battery is properly connected to the receiver, the flashlight lamp in the "valve saver" will light. If it fails to light, I know at once that there is something wrong in the filament circuit wiring of the receiver or with the "A" battery. If by any chance the "B" battery voltage is short-circuited to the filament, the

"valve saver" will burn out. These flashlight bulbs are cheap—certainly a great deal cheaper than the set of valves that would burn out if I had not used the device.

The construction of this "valve saver" is extremely simple, as reference to Figure 3 will disclose. The only materials required are a worn-out "B" battery (to supply the required sealing wax), a burned-out vacuum valve (only its base is used) and a 6-volt flashlight lamp, with socket.

The first step is to break all of the glass out of the vacuum valve, including the glass stem which contains and supports the internal elements. The two wires which run from the filament prongs of the socket to the ends of the



A CONVENIENT VALVE SAVER

FIGURE 3: Note that the parts which go to make up this testing plug are such as almost any fan would have in his possession.

filament should be left intact. The filament prongs are the two most distant from the bayonet pin on the side of the valve base. If these two wires should be broken, they should be replaced with others.

The flashlight socket is next placed within the valve socket and the two wires from the filament prongs are connected to the socket terminals.

To make the assembly rigid, heated sealing wax, taken from a worn-out "B" battery, should be allowed to flow into the valve base, so that the lamp socket will be solidly imbedded when the wax cools. If no blow-torch is available for melting the wax, this purpose may be accomplished by breaking the sealing wax up into small pieces and packing them into the socket with a hot soldering iron until they melt into one another.

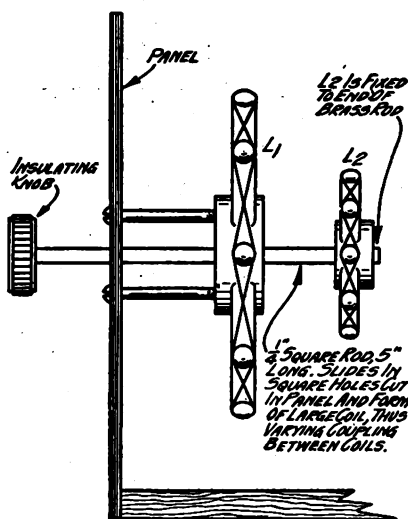
—H. B. CLOSSON, JR.,
Philadelphia, Pa.

The Old Haynes Circuit With Home-Made Coils

HERE is a three-circuit tuner which provides both sensitivity and selectivity and which can be constructed at a very low cost for parts. I have been using this circuit for some time and have tuned in 18 Chicago stations on the loudspeaker, as well as numerous other station located throughout the eastern and mid-western states.

The receiver has only one tuning control and a regenerative control which consists of a rod that slides in and out through the panel to move the tickler coil, L₂, toward and away from the tuning coil, L₁. This detail of the coil mounting is shown in Figure 4. The schematic circuit is shown in Figure 5.

The variable antenna coupling provided by the tapped portion of the coil, L₁, gives the high selectivity of this circuit. By this means, the antenna portion of the coil can be varied from three to fifteen turns, thus providing plenty of pick-up on the high waves and selectivity on the low waves. A switch lever with five switch points provides a convenient method of vary-



THE COIL DETAIL

FIGURE 4: The home-made coil constructed according to these specifications gives extraordinary results, according to its designer.

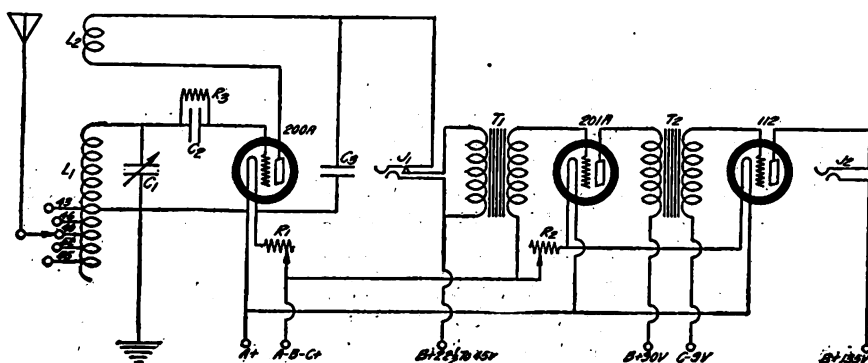
ing the coupling in the circuit.

I am passing this circuit along to other readers of POPULAR RADIO who may be interested in a small, cheap and easily constructed job that will produce real results—better results per dollar than any other receiver I have seen. There are no tricks about the circuit. The only caution to be given is to reverse the tickler leads if the receiver refuses to oscillate when it is first put into operation. Here is a list of parts used:

- C1—.0005 mfd. variable condenser;
- C2—.00025 mfd. fixed condenser;
- C3—.001 mfd. fixed condenser;
- L1—Spiderweb coil wound on a 3-inch form with 13 pegs; total of 55 turns of No. 20 DCC wire, with taps taken off at every third turn beginning with the forty-third;
- L2—Spiderweb coil wound on a 2-inch form with 17 pegs; 35 turns of same size wire as used for L₁;
- J1—Double circuit, closed type jack;
- J2—Single circuit, open type jack;
- R1—20-ohm rheostat;
- R2—6-ohm rheostat;
- R3—Variable grid-leak, 2 to 9 megohms;
- Composition panel 18 inches by 7 inches by 3/16 inch;
- Binding-post strip, binding posts, etc.

—SILENT E. A. NEGUS.

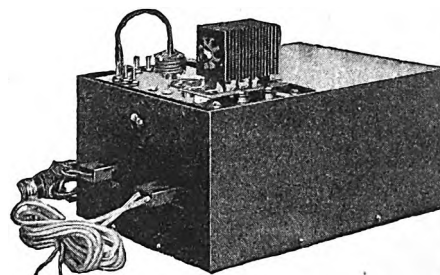
Block Island, R. I.



A CIRCUIT FOR DX WORK

FIGURE 5: The regenerative detector is at the left. By means of the jack, J1, the two-stage low-frequency amplifier may be plugged in or out, and head-phones inserted.

electrify your set the easy practical Knapp way . . .



The Kit completely assembled with metal cover in place. Operates on 105-120 volts AC, 50 to 60 cycles.

Knapp "A" POWER KIT

No expensive short lived AC Tubes, no troublesome re-wiring, no annoying hum. Increase instead of decrease the efficiency of your set, no waiting... the Knapp "A" Power gives you music *instantly* at the snap of a switch.

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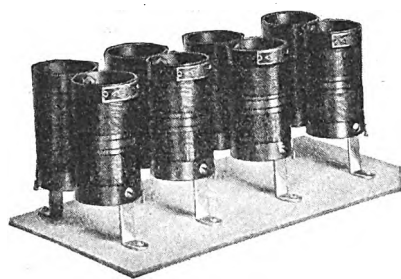
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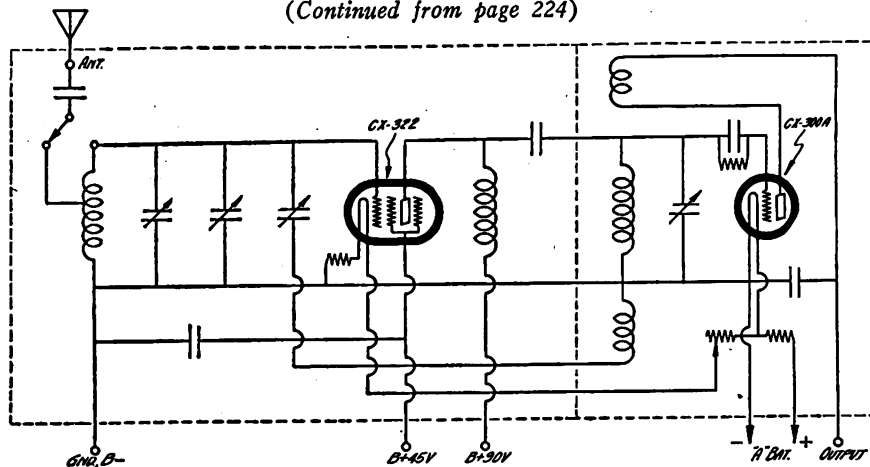
LC-28 KITS

We will be glad to supply you with the complete Kit of the LC-28 either for AC or DC operation. Write for prices.

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Screened-Grid Valves "Pep Up" the Browning-Drake (Continued from page 224)



THE SCHEMATIC CIRCUIT OF THE RECEIVER

FIGURE 4: This is the diagram of the circuit to be used with the two-valve tuner when a screened-grid valve is used in the high-frequency amplifier stage. Notice that a by-pass condenser is inserted between the shielding grid and the filament circuit. Also two small fixed resistors are added in series with the filament of the screened-grid valve, 10 ohms in the negative side and 5 ohms in the positive side.

micromicrofarads, across the antenna tuning system of the circuit, so that the trimmer condenser will completely compensate all over the wave-band. Sometimes it is not necessary to add this small condenser, for this result may be obtained by connecting the .0001 mfd. condenser in series with the antenna to the stator plates of the first tuning condenser. This puts the capacity of the antenna across the antenna tuning system, and as a result the compensating condenser has sufficient variation to take care of the difference in tuning of the two condensers which are operated on the same shaft.

Neutralization.

When the receiver is completely constructed and connected up as shown in Figures 1 and 4, neutralization may be done in the following manner:

The compartment which contains the detector circuit should have the shields completely on and fastened down tightly. The rear shield on the first compartment may be left off until after the neutralization process takes place.

The best way to neutralize is to set the dial at about 20 on the scale and then turn the tickler either in one direction or the other, until a distinct click will be heard in the reproducer. This means that the detector circuit is oscillating. Adjust the tickler coil until this circuit ceases to oscillate. A test to determine whether or not the circuit is oscillating is to place the finger on

the terminal of the .5 mfd. blocking condenser, which is connected to the stator plates of the second tuning circuit, when a distinct click will be heard if this circuit is oscillating. Now turn the tickler back until oscillation just ceases. Turning the trimmer condenser will then throw this circuit into oscillation if the neutralizing condenser is not properly set. The neutralizing condenser should be then set until the above test is satisfactory and the trimmer condenser has no effect on oscillations produced in the second circuit. It will be found that the neutralizing condenser is then almost at a minimum value.

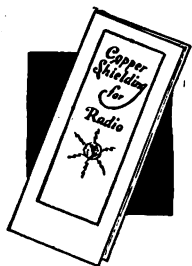
In this article a little different viewpoint from that generally accepted has been given on the use of screened-grid valves. The writer believes this to be scientifically correct, and it is sincerely hoped that this data may be helpful to experimenters as well as those who desire to build an up-to-date and sensitive radio receiver.

The receiver, of course, may be used with any good low-frequency amplifier and in the photo-diagram in Figure 1 it is shown connected to the General Radio push-pull amplifier, from which excellent results may be obtained, both as to quality and volume of reproduction. The diagram gives complete details for installation with specific recommendations as to the accessory apparatus that has been found satisfactory in tests made in POPULAR RADIO Laboratory.

A New Use for Screened-Grid Valves

Screened-grid valves make their debut as low-frequency amplifiers in the new Thordarson Inductor receiver, the construction of which will be featured in next month's issue of POPULAR RADIO. Here is something that the wide-awake fan will sit up nights playing with. Don't fail to get the constructional details.

DISTANCE *lends* ENCHANTMENT



Write for your copy of this book. There is no cost nor obligation on your part.

When you buy or build a radio set make sure that it has Copper Shielding. Where long distance reception is desired Copper Shielding is essential. It is a refinement to your set that will enable you to hear the programs of distant stations much more clearly.

Copper Shielded sets give:

BETTER RECEPTION
FINER SELECTIVITY
IMPROVED TONE QUALITY

By virtue of its easy working qualities and its high conductivity Copper Shielding is a decided improvement to any set.

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RESEARCH ASSOCIATION

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A QUICK ANSWER TO EVERY RADIO PROBLEM in "EVERYMAN'S GUIDE TO RADIO"

This book of 640 pages, size $5\frac{1}{4}'' \times 7\frac{1}{2}''$, containing more than 1300 finely engraved illustrations, has been prepared by some of the greatest physicists and engineers of radio. "Everyman's Guide to Radio" stands as the first successful effort to meet the needs of all those who aspire to attainments in the science, whether they are "broad-catchers," skilled service men or students. This vast wealth of information represents studied compilation that has extended over two whole years and includes every phase of radio communication that can have any interest to those desiring meaty information.

Intelligent use of "Everyman's Guide to Radio" gives quick, understandable answers to practically every radio problem regardless of the technical accomplishment of the reader. Special emphasis has been laid on the illustrations contained in the "Guide." Hundreds of specially prepared drawings and photographs answer most radio problems at a mere glance. No effort or expense has been spared to make the "Guide" of maximum value to radio listeners. It is the fascinating story of radio in pictures and it is the most complete collection of instructive radio photographs ever published.



Convenient!

A lot of information in a small space. Just the right size for the pocket and light in weight.

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So sure are the publishers of "Everyman's Guide to Radio" that this volume is just what everyone needs to complete his reference library and so sure are they that it is the most practical, complete and beautiful radio book yet published that they are willing to mail it to those interested for examination without obligation to buy. Just fill out the attached coupon and mail. The book will be mailed immediately. Upon arrival, you pay the postman \$4.00 plus postage. Examine the book for 5 days. If, after that time,

\$ 4⁰⁰

you are not convinced of the value to you, return in good condition and your money will be refunded, at once and in full, without question.

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Send me "Everyman's Guide to Radio" in one volume. I agree to pay the postman \$4.00, plus postage. If, after carefully examining the book for a period of five days, I do not like it I will have the privilege of returning it to you and my money, in full, will be immediately returned.

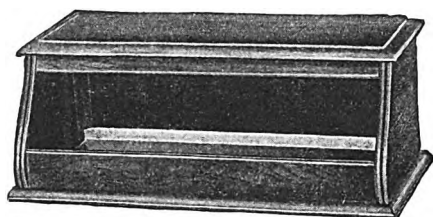
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Address.....

City.....State.....

CORBETT CABINETS

FOR THE LC-28

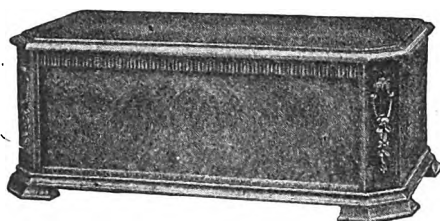


Model LC-28 Walnut \$18.00



Model LC-28-D-20 Walnut
\$70.00

The authorized cabinets for the LC-28. Made to take the aluminum 6x26-inch panel, with 25 degree slope.



Model "C" Walnut

The ultimate in elaborate and attractive radio cabinets is offered in our model "C." It is an adaptation of the old Italian Chests, being designed and decorated after the spirit of the Renaissance period.

Grooved for 3/16-inch panel with removable top rail. Fancy top stay and piano hinge are applied.

PRICE LIST

MODEL "C" CABINETS

Walnut Only

Panel Size	10 in. deep	12 in. deep	Weight	Mounting Boards
7x18	15.50	17.00	26	.30
7x21	17.00	18.50	28	1.00
7x24	19.00	20.50	31	1.10
7x26	20.50	22.00	34	1.20
7x28		23.00	37	1.30
7x30		24.00	40	1.40

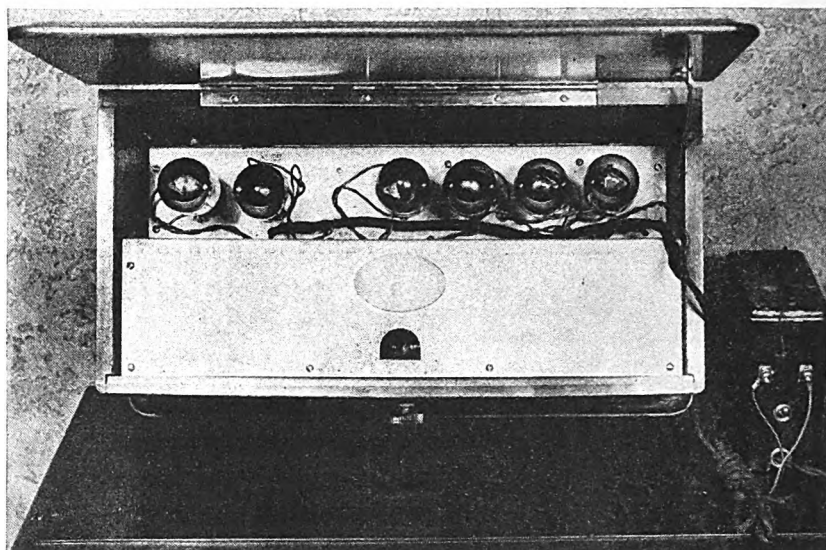
Corbett cabinets are in stock ready for shipment.

Write for illustrated folders.

CORBETT CABINET MFG. CO.
ST. MARYS, PENNA.

4 Minutes to Socket Operation

(Continued from page 225)



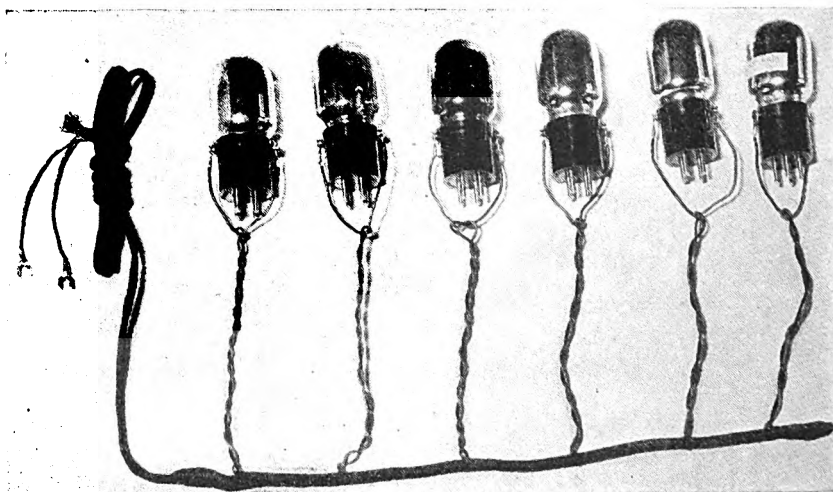
THE AC VALVES IN PLACE

As this view shows, the installation of the valves and harness does not require any tampering with the inner mechanism of the set. A person knowing nothing of radio could make the change.

ume control. This takes the form of a high resistance which is connected directly across the antenna and ground. The volume is, consequently, controlled by regulating the strength of the signal on the grid of the first high-frequency valve, and it will be found that very satisfactory results can be had with this simple arrangement. In no case should the user attempt to insert any variable resistances in the heater circuit of the AC valves. The heater current on these valves is critical, and any attempt to bring it below the normal operating value might prove harmful.

In special cases, the more serious kind of radio experimenters may desire to know something about the operating characteristics of these valves, for the purpose of experimental work.

The valves are offered in two types—the 608 and 608-a. The 608 valve is a detector and operates with a plate voltage somewhere between 45 and 90 volts. It has a plate impedance of approximately 8,000 ohms, a mutual conductance of about 1,000 and a voltage amplification between 7 and 9. The 608-a Marathon valve is intended for both high-frequency and low-frequency use. The plate voltage in this instance may be anywhere between the limits of 90 and 180. The plate resistance is approximately 9,000 ohms and the amplification factor between 7 and 9. This valve is self-biasing and requires no "C" battery in the grid circuit, except when the valve is used in the last low-frequency stage, where the usual 4½-volt "C" bias may be applied.



HOW TO APPLY THE HARNESS

The application of the adaptor harness to the AC valves is the simple matter of attaching the leads from the twisted cables to the special filament terminals on the sides of the valve bases.

The Aero Converter

(Continued from page 204)

6/32 machine screws $\frac{3}{4}$ inch long and nuts for fastening the instruments to the sub-panel.

Mount the coil frame of the coil, A, the socket, F, and the choke coil, D. Then fasten down the grid condenser, E, that is equipped with clips that may be fastened directly to the grid terminal of the socket and the adjacent coil terminal lug on the coil frame. Then attach the brackets, K1 and K2.

Next proceed to mount the two variable condensers, B and C, and the rheostat, G, on the front panel, I. The sub-panel, J, is then fastened to the front panel, I, by means of machine screws and nuts inserted through the front panel into the sub-panel brackets.

The mounting of the dials, H1 and H2, should be carried out in accordance with the instructions packed in the carton in which they come.

When all the construction work has been completed as shown in the illustrations, the unit is ready to be wired.

Wiring the Short-Wave Adaptor

The wiring should be done according to information given in the picture wiring diagram in Figure 3. This diagram shows the exact connections to be made to all the instruments and to the connector plug.

The next job will be to prepare the two filament leads and plate lead from this unit to the connector plug. This plug may be made from the base of a burnt-out UX type of valve. Remove the glass and other matter from the base and solder the three leads to their respective prongs. To avoid mistakes, check these instructions against the detail diagram in Figure 3.

When the wiring has been completed, the grid-leak, L, should be inserted in the grid-leak clips and the unit is now ready for connecting to the broadcast receiver.

How to Install and Operate the Short-Wave Adaptor

Insert the connector plug in the detector socket of any standard broadcast receiver with which it is to be used. In Figure 1, which shows graphically all the connections necessary in installing the unit, the Hammarlund Hi-Q "Six"

is taken as an example of standard receivers that may be used. There will be no extra batteries required for operating this unit. The connector plug may at any time be disengaged, the detector valve placed in its socket and the broadcast receiver restored to its use for reception on the regular broadcast band between 200 and 550 meters.

If a rheostat controls the filament voltage of the detector valve of the broadcast receiver, it should be set all the way "out," so that the filament voltage may be regulated by the rheostat, G, on the short-wave adaptor.

The antenna and ground connections are to be taken off of the receiver itself and applied to the antenna and ground posts of the adaptor. Refer to Figure 1 for these details of connection.

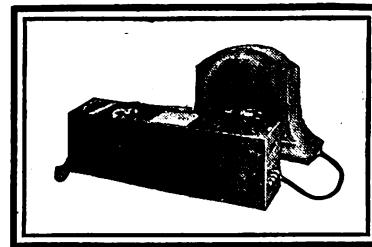
The antenna coil is loosely and variably coupled to the grid coil. These two coils are part of the coil assembly, A. The grid coil is tuned by the variable condenser, B. Regeneration is controlled by the condenser, C. For the most satisfactory reception, it should be turned up until oscillation in the circuit just starts and then it should be turned back just below this point.

For maximum results, it is recommended that a Zetka ZD valve should be placed in the valve socket in the adaptor and a Zetka ZAF valve for the first stage and a Zetka ZAO valve for the last stage sockets in the Hammarlund Hi-Q "Six" receiver. These valves are of low impedance and provide exceptionally high amplification.

By interchanging the coils, the various short-wave ranges may be covered. The dial settings of all stations received should be recorded, along with the size of the coil used for each particular station. This complete data should be kept so that the station may be tuned in again by referring to it.

The unit may be placed in a standard Corbett cabinet measuring 7 by 14 inches.

When this device is properly installed and when the operator becomes familiar with the method of tuning, stations literally thousands of miles away may be picked up on short waves.



Showing R. C. A. Radiola "28" Power Pack with 100-A Speaker—Powerizer Power Pack—\$84.00

Now You Can POWERIZE

Reg. U. S. Pat. Office

The Radiola "25" and "28"

Owners of the Radiola "25" and "28" can now enjoy the finest radio music in the world. With the Powerizer power plant you not only operate your set direct from A. C. socket, but you use the UX-210 super-power amplified Radiola in the last audio stage. This is the same super-power amplifier that is used in the 104 loud speaker in the Radiola "32" and which is to a great degree responsible for their excellent volume and tone quality. The Powerizer Power Pack not only supplies the necessary A B C current, but completes the audio system of the set.

Powerizer makes every set more than an AC electric—it makes it a Powerized Amplified DeLuxe Receiver.

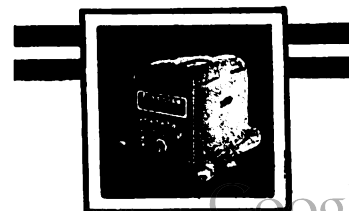
You can make every standard set a power amplified DeLuxe receiver—a set that will give you remarkable tone quality. Powerizer is the same tone and power plant that is used in \$800 and \$1,000 DeLuxe radios and phonographs. Powerizer is the only proven permanent source of power that gives Powerized amplification. Thousands and thousands of Powerizers are now in use throughout the country.

Write for Bulletin P. R. 1018-1019.

Licensed by Radio Corporation of America and Associated Companies.

General model with harness for all standard sets—\$60.00
Radiola "20"—\$59.00.

RADIO RECEPTOR CO.
106-7th Ave., New York City



Screened-Grid Valves Make

Still a More Powerful LC-28—

Keeping up with radio progress is a strenuous business, but POPULAR RADIO feels that the LC-28 receiver is so splendid an instrument that it deserves the best that radio can give. Accordingly, next month, constructional data will be given for installing two stages of screened-grid valve amplification on the LC-28, thus making it the most modern receiver available to the fan and set builder.

Proven Parts That Are Popular With Set Builders

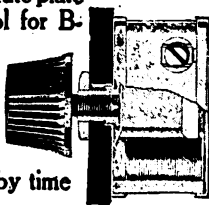
Bradleyunit-A



provides the ideal resistance for B-eliminators requiring fixed resistors of permanent resistance value. Not affected by age, temperature or humidity. Will not deteriorate in service.

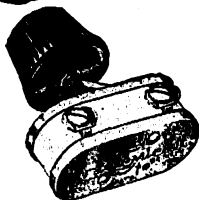
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provides accurate plate voltage control for B-eliminators. Used extensively by B-eliminator manufacturers. Not affected by time or moisture.



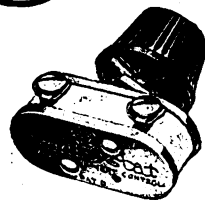
Bradleyleak

A variable grid leak that assures the ideal grid leak value. Easily installed on any set. Enables operator to get the best possible results with any tube.



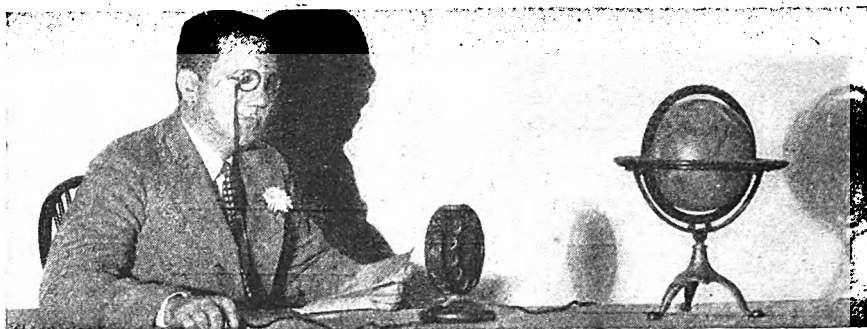
Bradleystat

This pioneer in filament control of radio tubes is still mighty popular. Provides noiseless, stepless filament control for all tubes. Try a Bradleystat on your next set.



Allen-Bradley Co.

Electric Controlling Apparatus
MILWAUKEE, WISCONSIN



BROADCASTS

Radio Ranks Sixth in U. S. Industries

RADIO'S total volume of business last year was \$550,000,000, ranking it sixth among the industries of the country, according to J. L. Limes, of the Crosley Radio Corporation. This astounding total has been reached in a seven-year boom from the \$2,000,000 business of 1921—the most phenomenal industrial growth in history. In 1921 the business consisted largely in crystal sets and three-circuit tuners. In 1922 came the neutrodyne receiver, using four and five valves, raising the business to a \$60,000,000 level. In 1923 the total was \$150,000,000, in 1924 \$350,000,000, and in 1925 \$410,000,000. In 1926 the manufacture of six, seven and eight-valve receivers brought the total to almost the half-billion mark, and 1927 took the total well above that level. During 1927 six-valve receivers proved to be the best sellers.

Where is the Radio "Saturation Point?"

TWENTY times as many sets as are now being used would be needed to satisfy fully the potential world radio market, according to the estimate of the Department of Commerce. The 18,000,000 receiving sets now in use throughout the world serve about 90,000,000 of the earth's inhabitants, or approximately 9 per cent of the population of existing zones of constant radio reception. If the zones of broadcast service were extended to include the whole world, 350,000,000 sets would be required. So the bugbear of radio "saturation" is still a good many decades in the future.

From Bananas to Bach in Radio Taste

RADIO fans who once clamored for jazz of the very hottest sort are now listening—with favor—to the classic compositions of Bach, Mozart and Haydn, says Victor Saudek, of the KDKA Little Symphony Orchestra. Mr. Saudek, who has been making programs for broadcast fans almost since broadcast-

ing began, has observed a steady rise in taste since the time when he organized the first orchestra ever formed for the exclusive purpose of broadcasting. After the first cry for red-hot jazz had cooled down somewhat, the day of the ballad and heart song came. Light opera followed, with Victor Herbert bringing in floods of fan letters. Then, about three years ago, such standard pieces as the Overture to "William Tell" and "Poet and Peasant" began to be called for. Mr. Saudek states that at present most of his letters call for the various classical serenades, minuets and shorter works of Mozart, Schubert and Haydn. With such phenomenal progress in the past, Mr. Saudek is now looking towards a future in which the public will demand complete symphonies by the classic masters, and the works of modern orchestral composers.

The Future for Socket-Operated Sets

WITH seventeen out of every twenty-six homes in the United States wired for electric lights, the future of the all-electric sets in this country looks rosate in the extreme. The seventy-five million people whom these homes represent are a market that has barely been touched by the newly developed all-electric receivers and other power devices that operate from the lighting lines. And since the number of electrically wired houses is increasing yearly (the increase in 1927 was 7½ per cent) it can be seen that socket operation for radio receivers is in for a long and happy period of prosperity.

Radio; Necessity or Luxury?

WORLD-WIDE tax information indicates that radio is classified in almost every nation on the earth as a necessity, and not as a luxury. France and Spain alone classify radio as a luxury in their taxation programs; France levies a 12 per cent tax on more expensive sets, and a 2 per cent tax on cheaper products, while Spain has a 5 per cent *ad valorem* rate. About a dozen countries levy a sales, or excise, tax, imposed generally on almost all products, including radio.

An All-Electric LC-27*(Continued from page 220)*

external filament terminals of the connectorald No. 926 GT. Place the Na-Ald RY-500 resistor on the three terminals provided. Now connect the green twisted pair of wires to the external heater binding posts of the No. 927 UY connectorald.

Place the Na-Ald No. 926 GT. connectorald in the last or power valve socket of the LC-27 receiver and the remainder of the connectoralds in order and insert a CX-326 type valve in the first, second and fourth (red) connectorald sockets, starting from the high-frequency end of the set. Insert a CX-327 valve in the third (green) or detector socket. Insert a CX-371 valve in the fifth (orange) or last socket. The set itself is now ready for AC operation.

Having accomplished the above operations, the builder may now connect the 5-volt (orange) filament leads, the 2½-volt (green) heater leads and the 1½-volt (red) filament leads of the harness to the terminals of the Jefferson AC filament transformer as shown in Figure 1.

Run wires from the negative, detector, amplifier and power binding posts of the Majestic power-pack to the corresponding terminals of the LC-27 receiver, using a Gavitt 5-wire cable. Also connect the "C" negative (—) power binding post of the receiver to the "B" negative (—) binding post, since "C" bias is provided by the resistors in the connectoralds. Join the antenna binding post of the receiver to an Electrad socket antenna, and the ground binding post to a water pipe.

A DeJur 500-ohm variable resistor is placed across the antenna and ground binding posts as a volume control. Use a good reproducer, such as the Air-Chrome balanced tension reproducer, for best results with power operation.

Plug the AC power supply cords of the Majestic "B" power-pack and the Jefferson AC filament transformer into a double socket and the receiver will operate as soon as the heater type detector tube warms up. It will be found that the new AC valves will give improved results over the older DC valves, aside from the complete AC electrical operation, and the receiver should now compare favorably with the latest type of AC receiver.

The electrification of other sets of similar characteristics may be done in a similar manner. If any set requires an additional grid resistor for stabilizing the high frequency stages, the Na-Ald resistor No. R of any value from 500 to 1,000 ohms may be inserted in the slots of the connectoralds. The diagrams in this article apply to any set using two stages of high-frequency amplification, a vacuum valve detector and two stages of low-frequency amplification with a power valve.

A. C. OPERATION!

The Type 440-A Transformer illustrated is designed for use on 105-125 V. (50-60 cycle) A.C. and is rated at 65 watts. The following voltages and currents are available:

2 Volts.....	10 Amperes
3.5 "	5 "
5 "	2.5 "
7.5 "	2 "



Type 440-A Transformer
Price ... \$10.00

The use of this transformer, together with the new A.C. tubes and a dependable plate supply unit such as the General Radio type 445 Plate Supply and Grid Bias unit, makes the conversion of a battery operated receiver into one operated from the light socket very simple. If you do not care to undertake this change yourself, go to your community set builder. He is well qualified to serve you.

GENERAL RADIO CO.

30 STATE STREET :-: CAMBRIDGE, MASS.

Write for Bulletin No. 929

GOOD NEWS!

FOR PROFESSIONAL SET BUILDERS

DURING 1928, it is estimated that over ten million dollars will be spent in the purchase of receivers made by professional set-builders throughout the United States. Orders for custom made receivers are now being booked at an unprecedented rate and everywhere set builders are becoming more alert to the potential money-making possibilities of their craft. To help these men, POPULAR RADIO has prepared some special data which will, for a limited time, be distributed free of charge to those who write for it. Those who desire this information need only answer the following questions:

1. How many sets do you construct each year?
2. What receivers are you specializing in?
3. What do you spend for radio parts each year?
4. How long have you been in business?
5. Do you operate in full or spare time?

Address all inquiries to the Service Department

POPULAR RADIO, Inc.

119 West 57th Street

New York, N. Y.

LYNCH



25 Radio Ideas Plus

for improving the tone quality and distance-getting ability of your set are explained in this valuable radio book. Charts, specifications, and wiring diagrams show you how to make easy improvements at little cost. Be your own radio mechanic. Send 25c (stamps or coin) with the coupon or see your dealer for your copy.

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Gentlemen:

I want to improve my radio. Please send me a copy of "Resistance the 'Control Valve' of Radio" for the enclosed 25c.

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P. R. 3

Increased Amplification by simple change in valves



Exact size photograph of the new Donle-Bristol DA-2 amplifying valve. Price \$3.00 each.

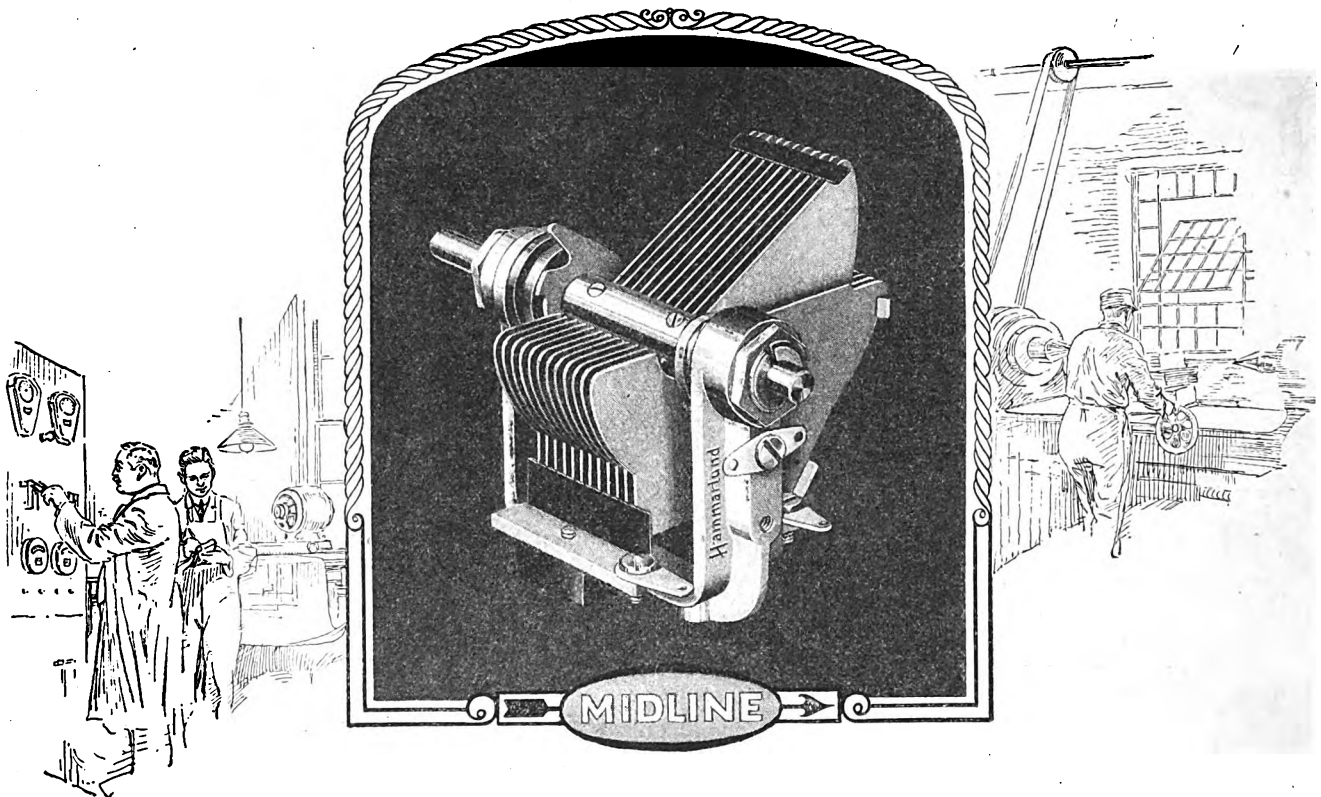
This new 6-volt amplifying valve is the latest production of Harold P. Donle, inventor of the already-famous sodion detector valve.

The Donle-Bristol DA-2 has a new type of oxide-coated filament, producing a much higher emission. It is used successfully in the high frequency amplifier of any standard DC set, with no changes of any kind in the circuit.

Each valve used increases the amplification from 30 to 50%—a gain at least equal to that which would be secured by an additional radio stage.

Complete characteristics will be mailed upon request, and if your dealer has not yet secured his stock, mail orders will be promptly filled by the manufacturers.

THE DONLE-BRISTOL CORPORATION
MERIDEN, CONNECTICUT



The Whole Radio World Applauds HAMMARLUND PRODUCTS

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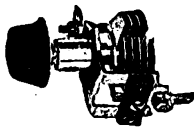
From the famous Hammarlund Midline Condenser, in single and dual models, clear through to the tiny equalizing condenser, you will find assurance of high quality and superior performance.



Illuminated DRUM DIAL

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A new, high-ratio midget condenser with all the distinctive Hammarlund features—plus sturdier, simplified construction. Has new locking device for fixing rotor plates in any position. Knob included.

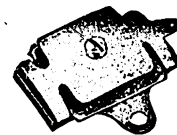
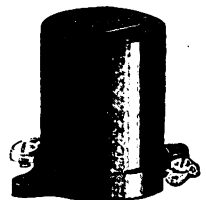


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Are Officially Specified
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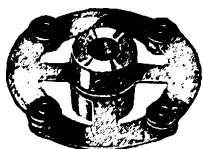


Equalizing CONDENSER

For neutralizing R.F. circuits or equalizing multiple tuning units. Small size fits limited space. Bakelite base, mica dielectric, phosphor-bronze spring plate.

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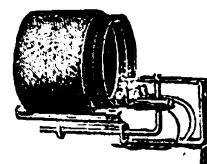
HAMMARLUND MANUFACTURING CO.
424-438 W. 33rd St. New York



Flexible COUPLING

Permits coupling condensers in tandem without exact alignment. Two sides electrically independent. Bakelite insulation.

For Better Radio
Hammarlund
PRECISION
PRODUCTS



The New AUTO-COUPLE

Designed for use with the Hammarlund Drum Dial. Specified for the New Hammarlund-Roberts Hi-Q Six Receiver.



Popular Radio

EDITED by RAYMOND FRANCIS YATES



FOUNDED 1911

VOLUME XIII

April, 1928

NUMBER 4

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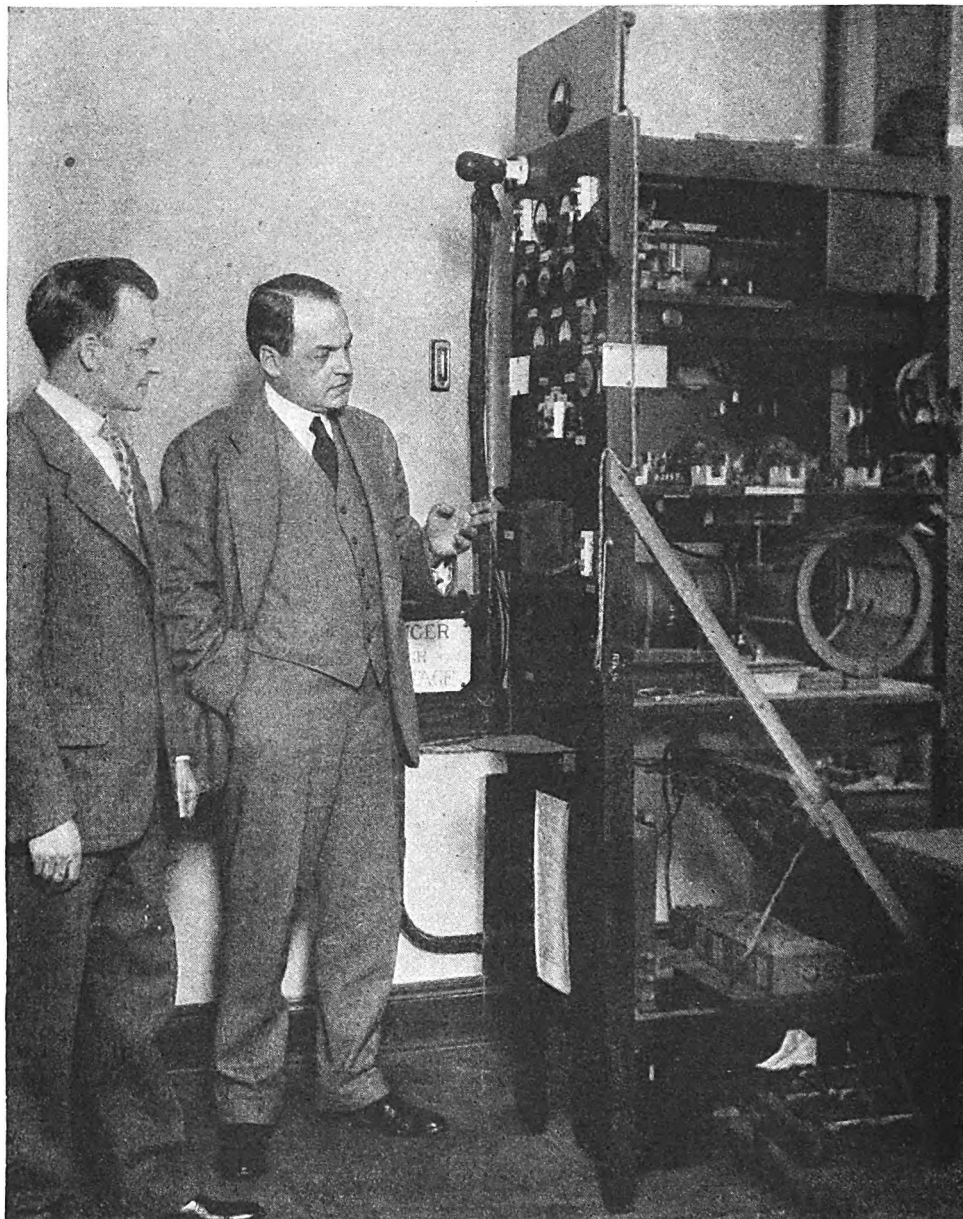


"Popular Radio's Progressive Spirit . . ."

"I have always been a silent admirer of POPULAR RADIO's progressive spirit, and I think I should give expression to this admiration which I feel. Especially do I recognize the service that the publication renders to its readers in telling them how to employ in their radio experiments only the best of manufactured products."

S. I. Cole

TREASURER
AEROVOX WIRELESS CORPORATION

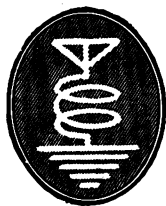


Underwood and Underwood

The Watchdog of the Ether

The instrument shown above is probably the most accurately tuned radio transmitter in the world. It is known as station WWV, and it is operated by the United States Bureau of Standards for the purpose of giving the broadcasters of the land an accurate check on the frequencies at which they broadcast. Once a month WWV goes on the air with a "program" of standard frequency broadcasts. At each broadcast eight standard frequencies are transmitted, consisting of an announcement of the frequency followed by a series of long dashes of the correct frequency. Broadcasters and experimenters not on the exact wavelength of the transmission may obtain their calibration by means of harmonics. Station WWV is under the watchful care of Dr. J. H. Dellinger, who is shown here (left) explaining its operation to Radio Commissioner Orestes H. Caldwell.

Popular Radio



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Radio Sounds That Burn

Sounds that burn, that disintegrate animal blood, that cause terrific unheavals among the molecules of matter that is exposed to them—such sounds have been produced by transforming the rapid oscillation of high-frequency radio currents into mechanical vibrations. These “sounds,” of course, are inaudible, for they lie far beyond the limit of the human ear and can be reproduced only with the aid of a piezo crystal “loudspeaker”; yet their existence is testified to by the amazing effects they are able to produce.

By KELVIN THORNTON

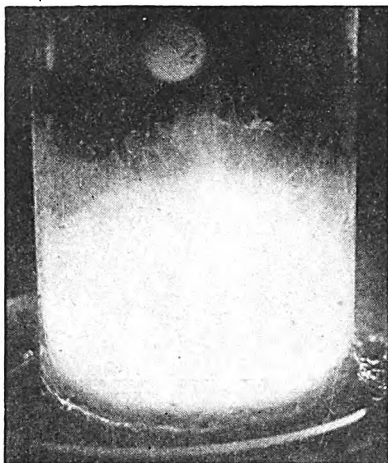
EVER since electrical science reached its age of discretion, the idea of a ray or vibration fatal to human life has held the imagination of the experimenter and the general public alike. Death rays have continually been “discovered,” and usually exposed as fakes, and volumes have been written of the possible dire consequences of wars waged with destructive electrical vibrations. The conversion of electrical vibration of the order of those used in radio transmission into mechanical vibration has been suggested frequently in the past as a means of producing this imagined death vibration, but until recently this conversion has been confined to paper speculation and popular novels. It has remained for Professor Wood, LL.D., of the Johns-Hopkins University, to make the actual test of the consequences of producing physical vibrations of the order of 300,000 cycles—a frequency equal to that of a 1,000-meter radio transmitter. And, although it cannot be said that the “death vibration” which writers have fancied has been produced, the effects of this vibration are so amazing that they add a new chapter to the wonders of science.

Of course, the results of the experiments were, to a certain extent, predicted in the work of John Tyndall, the brilliant English physicist of the 19th century, whose researches are embodied in the classic work, “Heat as a Mode of Motion.” In this treatise Tyndall speaks of temperature as being caused by the unorganized vibration of the atoms of matter. While the frequencies of these caloric vibrations are far higher than any of those used in Dr. Wood’s experiments, the latter’s experiments prove that very astonishing heat effects can be produced by mechanical vibrations of the order of the high-frequency currents used in radio.

It is quite easy to produce electrical vibrations of a very high order. With short-wave oscillators, electrons can be made to swing back and forth in circuits as rapidly as ten million times a second. However, we have no sound reproducing apparatus that would respond to these prodigious speeds. If we should let such currents flow through an ordinary loudspeaker, nothing but silence would prevail. In the first place, the diaphragm of the loudspeaker would be too bulky and massive to respond to

these rapidly-moving currents and, even if it were able to respond, the human hearing apparatus would not be able to detect the sounds produced. Thirty thousand vibrations per second represents the absolute limit of the capacity of the human ear drum.

In his search for a “loudspeaker” that would dance to the tune of these ultra-rapid vibrations, Professor Wood turned to the use of quartz crystals. It is well known that a plate of quartz, cut from a crystal in the proper directions, has the curious property of expanding and contracting under the influence of a periodic electrical field which may be supplied by two thin metal plates in contact with the opposite surfaces of the quartz, and joined to the terminals of a high-frequency electrical oscillator of sufficient power. Calculations show that a quartz crystal or plate 1 cm. in thickness will respond to a natural frequency of about 300,000 vibrations per second. Consequently, if the crystal is placed in a circuit of powerful electrical oscillators tuned to the same frequency, resonance occurs, and the amplitude of the vibrations of the quartz crystal becomes very great.



Scientific American

RADIO SOUNDS MAKE "SMOKE" FROM LIQUID

Benzol placed on water and brought into contact with matter vibrating at the rate of 100,000 cycles a second, suffers such severe molecular shock that it is rapidly dissipated into the thin, white vapor shown above. Here again the rapid vibrations demonstrate phenomena that have heretofore been associated only with vibrations in the heat portion of the spectrum.

It was by the use of a crystal of this type that Professor Wood was able to study the mechanical effects of such astounding rates of vibration.

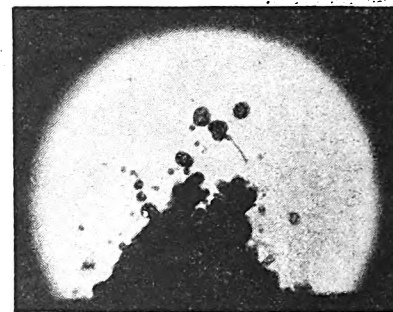
The "still" sounds produced in this way are capable of many curious feats. A glass tube, vibrated at a rate of 300,000 oscillations per second, will sear the flesh of the fingers if it is squeezed tightly. Benzol on water is thrown into such violent action that it is driven off into the air as fine mist or smoke. Frogs swimming in liquids vibrating at this high rate are killed, and glass tubes eventually succumb to the super-sonic frequencies that disrupt the ordinary molecular organization.

While ordinary quartz crystals such as those sometimes employed in amateur transmitters may be made to vibrate at super-audible frequencies by the use of a small oscillator, the

amplitude of their vibrations is very small and unsuited for the work which Dr. Wood undertook. To obtain sufficient intensity, a 2-kilowatt oscillator which had originally been designed for an induction furnace was used, together with a bank of oil condensers and a large variable air condenser used with several pairs of coaxial coils for raising the voltage. The primary coils were made up of from 7 to 20 turns of Litzendraht cable, the resulting coils varying from 16 to 20 centimeters in diameter. The secondary coils, wound on glass cylinders and containing from 100 to 250 turns, were mounted within the primaries.

Equipped with this generator of super-sonic frequencies, a diagram of which is illustrated in Figure 1, Professor Wood set out to explore the wonderland of sounds that burn and explode. By the use of this apparatus with a quartz crystal cut to suitable size, sounds—if they may be called sounds—were generated with frequencies of from 100,000 to 700,000 cycles per second. The plates, which were in the form of circular discs, rested on sheets of lead at the bottom of a dish of transformer oil. The top electrode, which was formed by a disc of very thin sheet metal, rested on the upper surface of the quartz.

It was during his early researches that Professor Wood found that it was necessary to immerse the quartz in oil, to accommodate the potential of 50,000 volts generated by the powerful oscillator. With the use of such high voltage, it was found impossible to produce the effects outlined without the immersion in oil. Not only would there be sparking around the edges of the electrodes, but the quartz plate would be broken to pieces as a result of the extreme vibrations that would be induced in it by the action of the currents. By immersing the crystal in the oil bath, sparking was overcome and part of the



Scientific American

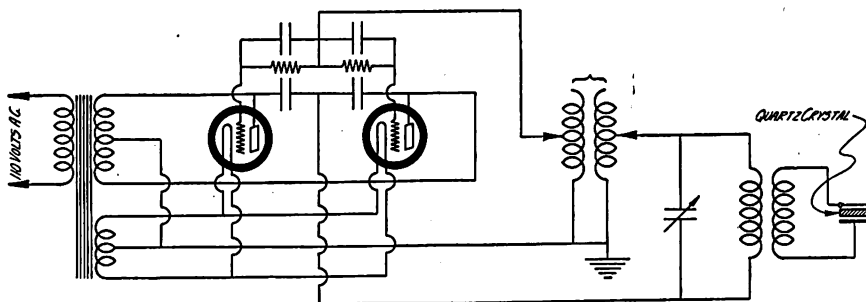
SOUND ERUPTIONS IN OIL

This miniature volcanic eruption took place on the surface of a vessel of oil which was subjected to high-frequency sound. The terrific shock sustained by the particles of oil is very apparent in the heaped up mound of liquid and the flying particles of oil.

energy imparted to the crystal was sufficiently dissipated by the emission of compressional waves in the oil. Ever with this arrangement, Professor Wood was always on the borderland of danger; for it was found that increasing the voltage much beyond this point resulted in a loss of crystals.

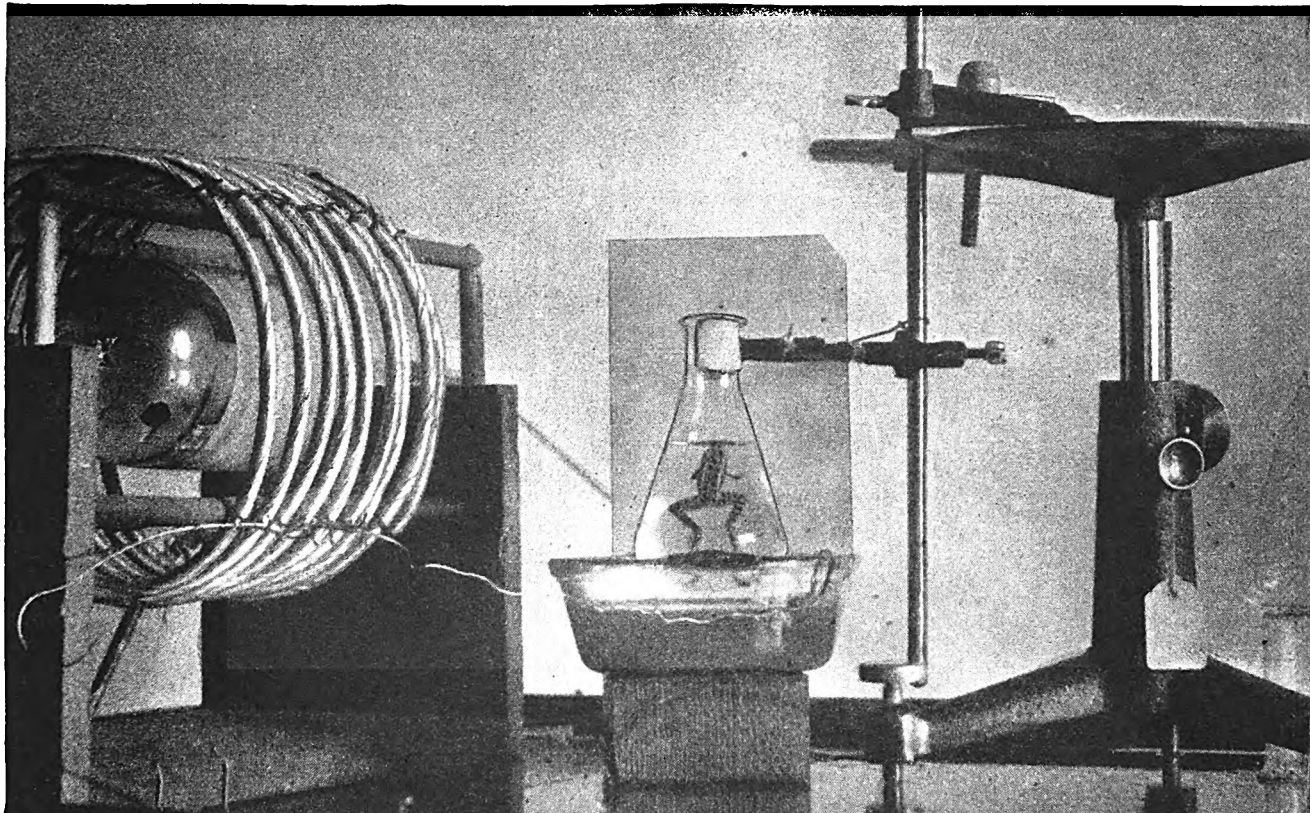
A beaker of water lowered to a point beneath the surface of the oil demonstrated a most remarkable phenomenon. The super-sonic frequencies at which the molecules of oil were responding was instantly communicated through the glass to the water in the beaker. The surface of the water was at once pushed up into a mound, while millions of infinitesimal air bubbles appeared in the fluid. When water is heated, precisely the same effect is produced; there is a rapid movement of dissolved air in the form of bubbles to the surface of the water. In this particular case, however, the bubbles did not go immediately to the surface but became entrapped in the nodes of the standing waves which had been formed by interference from the direct waves with those reflected down from the surface. When subjected to the same process, mercury was blown into clouds of fine particles projected up through the water, which soon became as black as ink.

Maximum heating effects were produced with a small flat-bottomed conical flask drawn out to a rod at the top of about $\frac{1}{2}$ millimeter in diameter. The flask was mounted on a solid support in a vertical ring and pinion device, and the distance between the flask and the crystal plate could be accurately adjusted. By bringing pine chips in contact with the top of the rod, these were caused to emit sparks and holes were burned through them.



THE OSCILLATOR CIRCUIT

The input from the 110-volt AC lines is amplified by means of the vacuum valve oscillator circuit in the center; the output of the valves is fed into the tuned primary of the coil at the right. The secondary of this coil actuates the crystal which translates the electrical vibrations into mechanical vibrations.



Scientific American

AN EXECUTION STAGED WITH SILENT SOUND

This view shows clearly the arrangement of apparatus used in the execution of a frog by means of supersonic sound. At the left is one of the coils of the oscillator used for generating high-frequency electric currents. The small dish in the center is filled with oil, and the leads from the oscillator are connected to a crystal immersed in it. Dipping into the oil is a flask of water in which a frog awaits execution when the vibrations of the crystal are transmitted through the oil to the water in the flask.

When a chip of wood was pressed tightly against a glass rod in contact with the sound generator, the rod was set to vibrating at high speed, and the chip burned. When the same glass tube was permitted to come in contact with a plate of glass, it pushed its way through, displacing the glass in the form of fine white powder. By dusting circular glass plates with lycopodium, and subjecting the plates to the ultra-rapid vibrations, the powder arranged itself in symmetrical forms having a lace-like appearance.

Among other interesting experiments performed by Dr. Wood was that of drawing out a glass tube and spraying the constricted area with oil. When exposed to the extreme vibrations by placing the bottom of the glass tube in contact with the rapidly vibrating supersonic generator, the oil escaped into the surrounding atmosphere in the form of fine mist or spray, which fully demonstrated the exceptionally violent action into which the molecules of the oil were thrown.

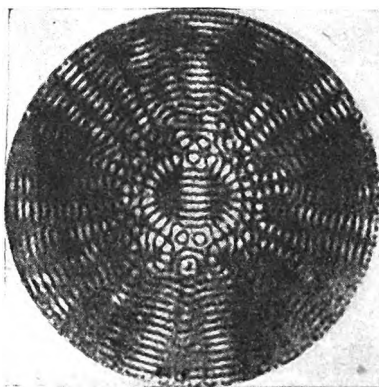
Perhaps the most interesting of all these many experiments was that which tested the biological effect produced by the vibration. Red blood corpuscles

were completely destroyed and the salt solution in which they are suspended quickly lost its turbidity and became a clear, red color very similar to the solution that would be produced by aniline dyes. Unicellular organisms, such as

paramecia, were almost instantly dispatched and the cells torn open.

An especially beautiful and revealing experiment was performed by coating the inside of a two-foot length of glass tube, one inch in diameter, with a film of very heavy oil. When the end of the tube was dipped into the vibrating bath, the film immediately gathered itself into a system of equidistant rings. These rings lined the tube from top to bottom and showed the positions of the nodes of the stationary waves formed by interference of the high-frequency vibrations which were at the time running up and down the tube.

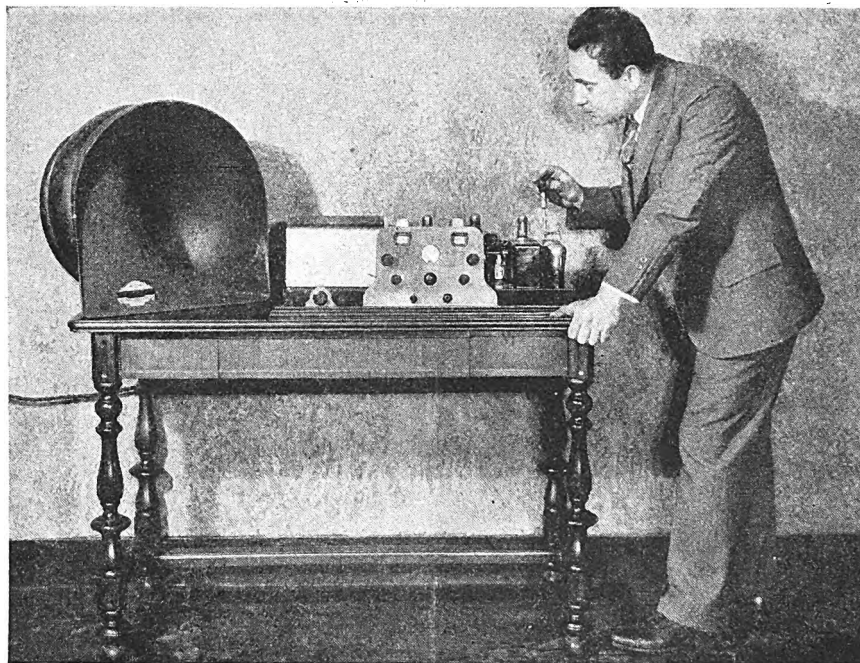
The increase in temperature caused by supersonic sound vibration was easily measurable, using an ordinary centigrade thermometer. As a matter of fact, it was during the application of the thermometer to the oil bath in which the crystal was immersed, that the experimenter actually discovered the uncomfortable effects produced by the high rate vibrations. Upon immersing the thermometer in the bath it was found that the friction between the vibrating glass and the skin of the operator became so great that a searing of the flesh resulted.



Scientific American

RADIO SOUND WEAVES THIS LACE-LIKE PATTERN

Although this intricate pattern is worthy of a Flemish needlewoman, it was produced when a fine powder of lycopodium was dusted over a piece of glass and vibrated at a supersonic frequency. The figures are formed by the interference of waves reflected from the rim of the plate to those radiating outward from the center.



ADJUSTING THE INFRADYNE AMPLIFIER

Since the Infradyne amplifier works on one frequency, it needs no attention after its initial tuning when the set is built. For local reception it may be switched out of the receiver circuit, with a consequent saving in operating voltages.

Plenty of New Ideas in the Remler Infradyne

By LAURENCE M. COCKADAY

THERE are few radically new circuits for radio reception offered to the experimenter or the radio enthusiast who builds his own set. The infradyne system, however, is different and offers some advantages that are not found in any other type of receiver circuit.

In the first place, the new infradyne receiver is a ten-valve set and is arranged so that instantaneous conversion may be made for local reception so that only five valves, with single dial control, are used. In this condition the infradyne comprises two stages of tuned-high-frequency amplification, a detector and two stages of low-frequency amplification. Operated on this circuit the receiver is sufficiently selective and will produce excellent tone quality on local reception. By a mere turn of the switch the set is changed so that two stages of high-frequency amplification are used, after which the signals are rectified by a detector valve, and a beat frequency produced by means of a local oscillator of approximately 3,500 kilocycles, at which frequency three extra stages of high-frequency amplification are used,

By inverting the principles of the superheterodyne, the Remler 10-valve Infradyne receiver, whose construction is described here, gives the set builder a brand-new circuit to play with—a circuit that brings in distant stations like locals, and gives the locals a volume and quality that few other receivers can match.

working into a second detector and two final stages of low-frequency amplification.

The receiver is not a superheterodyne; in fact, it works in exactly the opposite manner from the superheterodyne. Instead of the beat frequency being the difference between the initial frequency and that of the local oscillator frequency, it is the sum of these two frequencies, so that the signal will

appear on but one setting of the dial. Of course, the beat frequency is on a very short wavelength and the three-stage short-wave amplifier operates with the utmost selectivity without cutting sidebands or impairing quality of reproduction. This new form of amplification, beside amplifying the received signal to a remarkable extent, helps also to suppress a large amount of the noises that are amplified through the standard wavelength amplifiers ordinarily used.

An inspection of the new infradyne, as shown in the accompanying illustrations, will show that the new receiver presents a neat and pleasing appearance, that it is sturdy in design and compact in construction, and that in it have been incorporated all the latest improvements and electrical features in keeping with the latest developments in the field of radio. The schematic wiring diagram in Figure 4 gives the theoretical circuit in its entirety.

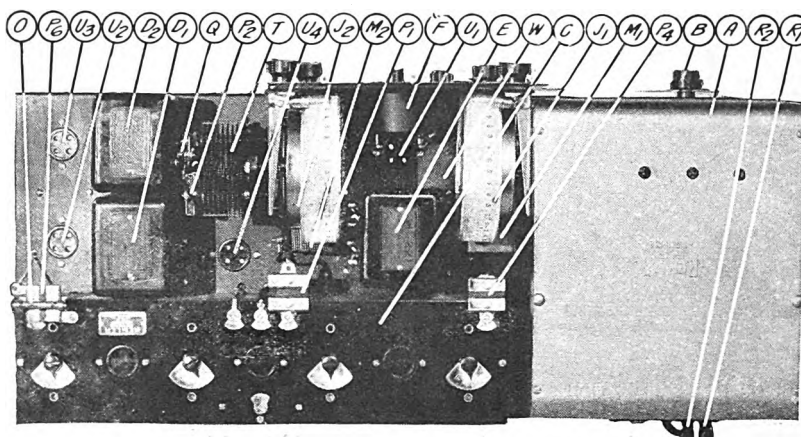
In construction this new set can be built by any one whether he is familiar with radio or not. When it is completed the constructor will have a re-

POPULAR RADIO WORK SHEET

THE REMLER INFRADYNE RECEIVER

LIST OF PARTS FOR BUILDING
THIS RECEIVERCOST OF PARTS—*Not over \$180.00*

- A—Remler high-frequency amplifier, No. 710;
 B—Remler antenna compensator;
 C—Remler Infradyne amplifier, No. 700;
 D1 and D2—Silver-Marshall low-frequency transformers, type 220;
 E—Silver-Marshall output transformer, type 221;
 F—Weston voltmeter, Model 506, 0 to 5 volts;
 G1 and G2—Remler cabinet and wooden base, No. 760;
 Remler Infradyne foundation kit, No. 750, consisting of:
 H1 to H3—Remler high-frequency chokes, type No. 35;
 I—Remler special oscillator coil;
 J1—Remler drum dial, No. 110-L;
 J2—Remler drum dial, No. 110-R;
 K1—Frost Gem Jac, No. 954, equipped with oxidized metal bushing;
 K2—Frost Gem Jac, No. 953;
 L1 and L2—Remler special bakelite terminal blocks;
 M1—Frost 10-ohm rheostat with extension shaft;
 M2—Frost 2½-ohm rheostat with extension shaft;
 M3—Frost 4-ohm rheostat;
 N1 to N3—Frost fixed resistances,

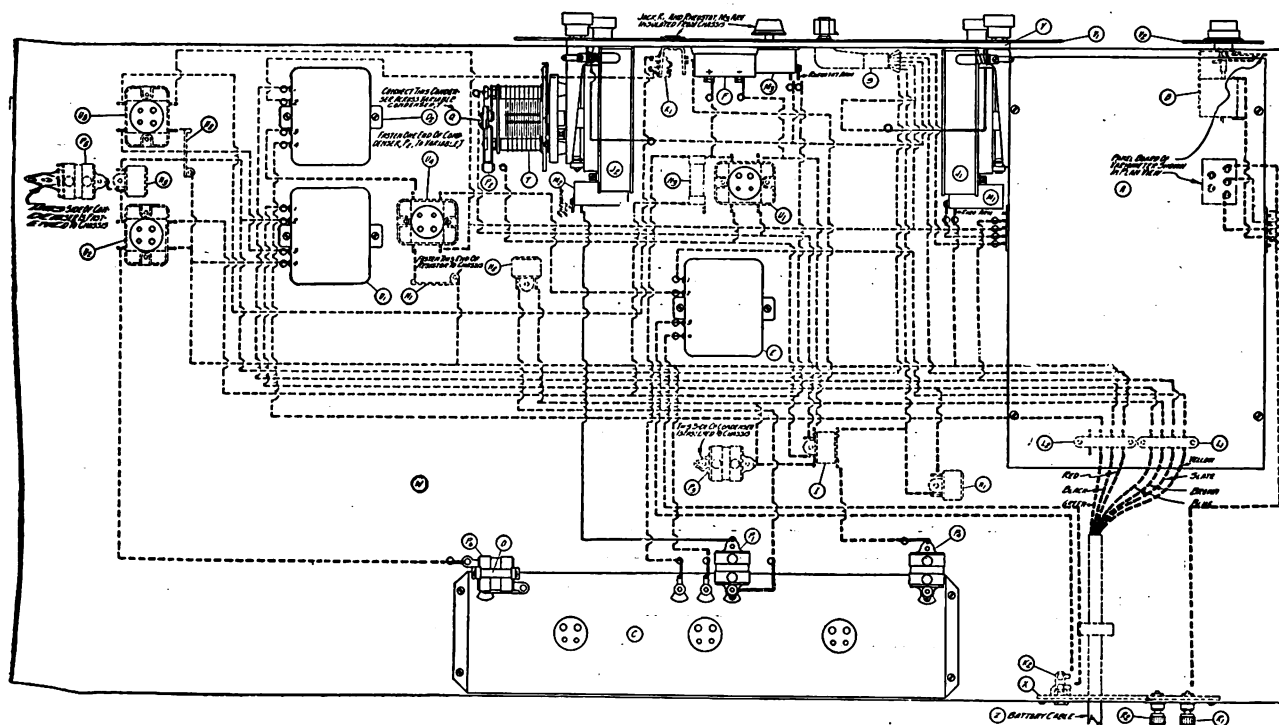


THE RECEIVER VIEWED FROM ABOVE

FIGURE 1: *The high-frequency amplifier, encased in its shield, appears at the right; the infradyne amplifier may be seen at the bottom of the picture, at the left.*

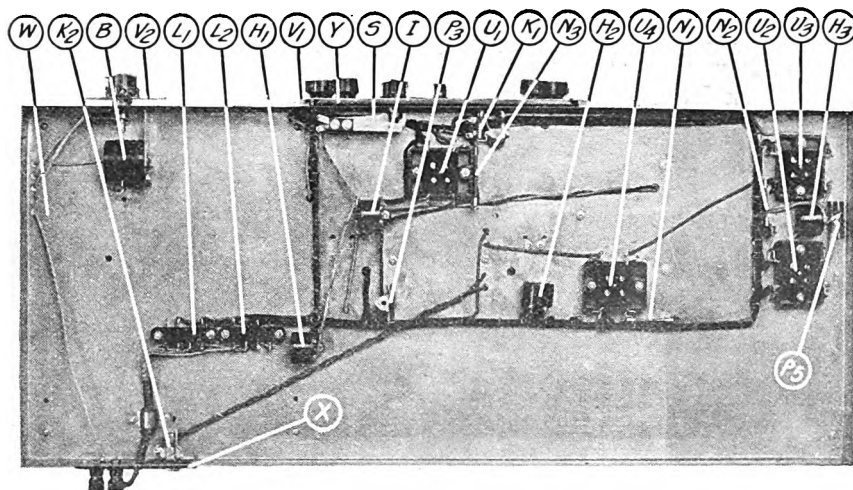
- 2 ohms, 4 ohms and 6 ohms, respectively;
 O—Durham metalized resistor, 4 megohms;
 P1 to P3—Electrad fixed condensers, .005 mfd., type P;
 P4—Electrad fixed condenser, .001 mfd., type P;
 P5—Electrad fixed condenser, .00025 mfd., type P;
 P6—Electrad fixed condenser, .00025 mfd., type GS, equipped with grid-leak bracket;
 Q—Special adjustable condenser with bracket attached;

- R1 and R2—Eby binding posts, marked *antenna* and *ground*;
 S—Yaxley switch, No. 69;
 T—Remler variable condenser, type 659;
 U1 to U4—Remler sockets, No. 50;
 V1—Remler bronze control panel;
 V2—Remler bronze antenna panel;
 W—Remler steel chassis;
 X—Bakelite binding-post strip, 4 by ¾ by ⅛ inch;
 Y—Pressed steel instrument panel;
 Z—Battery cable;
 Connecting wires, screws, nuts, etc.;
 Instruction book and blue prints.



HOW TO WIRE THE RECEIVER

FIGURE 2: *The wiring of the receiver is simplified by the fact that the high-frequency amplifier and the infradyne amplifier may be obtained completely wired.*



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 3: The method of cabling the wiring and the connections to the instruments mounted under the sub-panel are clearly shown in this view of the set.

ceiver that is absolutely up-to-date in design and performance, producing such excellent results for selectivity, sensitivity and reproduction qualities that he will be very proud to own it.

How to Construct the Receiver

The first job will be to mount the various instruments, parts and amplifiers on the metal chassis, W. It is preferable to start with the bottom side and to mount the antenna compensator, B, the terminal blocks, L1 and L2, the choke coils, H1, H2 and H3, the four sockets, U1, U2, U3 and U4, the condensers, P3 and P5, the resistances, N1, N2 and N3, the jack, K2, and the binding post strip, X, on the underneath side of the chassis, W. The correct positions for these instruments are shown in Figure 1. They are to be mounted on the chassis, in the screw holes provided for them, by means of

the screws, washers and nuts that are provided in the envelopes in which the instruments come packed.

After this is done the various instruments on the top side of the chassis should be mounted, including the high-frequency amplifier, A, the infradyne amplifier, C, the transformers, D1, D2 and E, the condensers, P1, P4 and P6, and the grid-leak, O.

Next mount the pressed steel instrument panel, Y, on the chassis, W. An envelope will be found containing screws for this purpose. When the instrument panel has been attached to the base mount on it the switch, S, the jack, K1, the right and left-hand drum dials, J1 and J2, the voltmeter, F, and the rheostats, M1, M2 and M3. These should be mounted without attaching the dials. Next put in place the bronze escutcheon plate, B1, and attach all the dials to the shafts of the instruments,

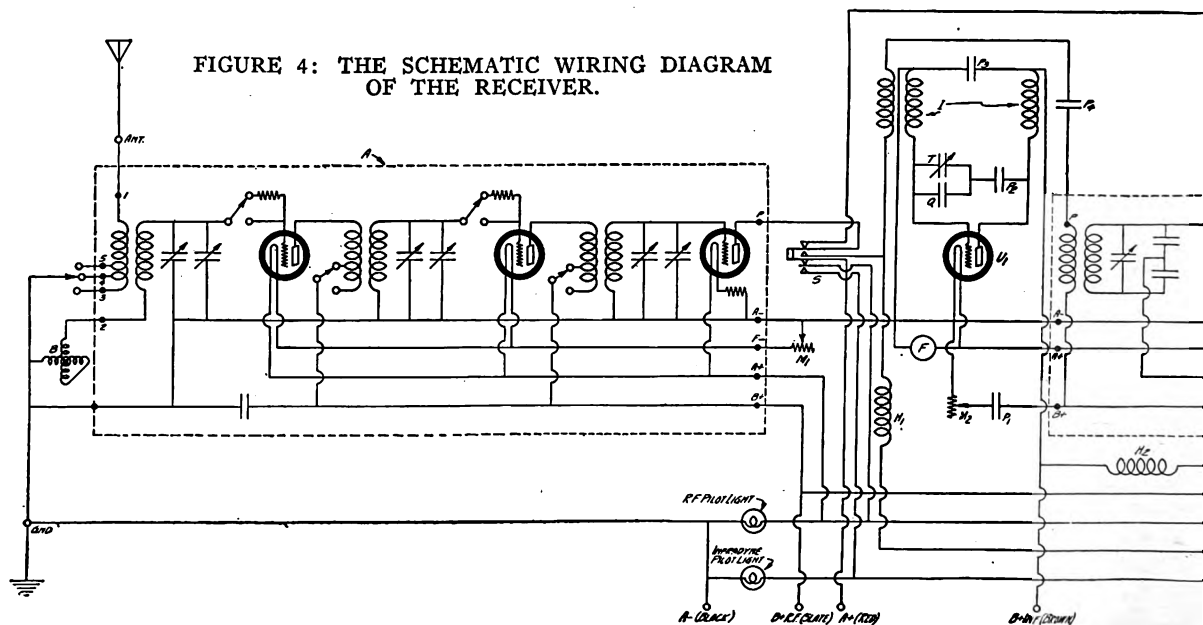
as well as the front of the jack, K1. The rheostat, M3, should be insulated with an insulating washer that is packed in one of the envelopes. Next attach the variable condenser, T, and on it mount the condenser, P2, and the adjustable condenser, Q.

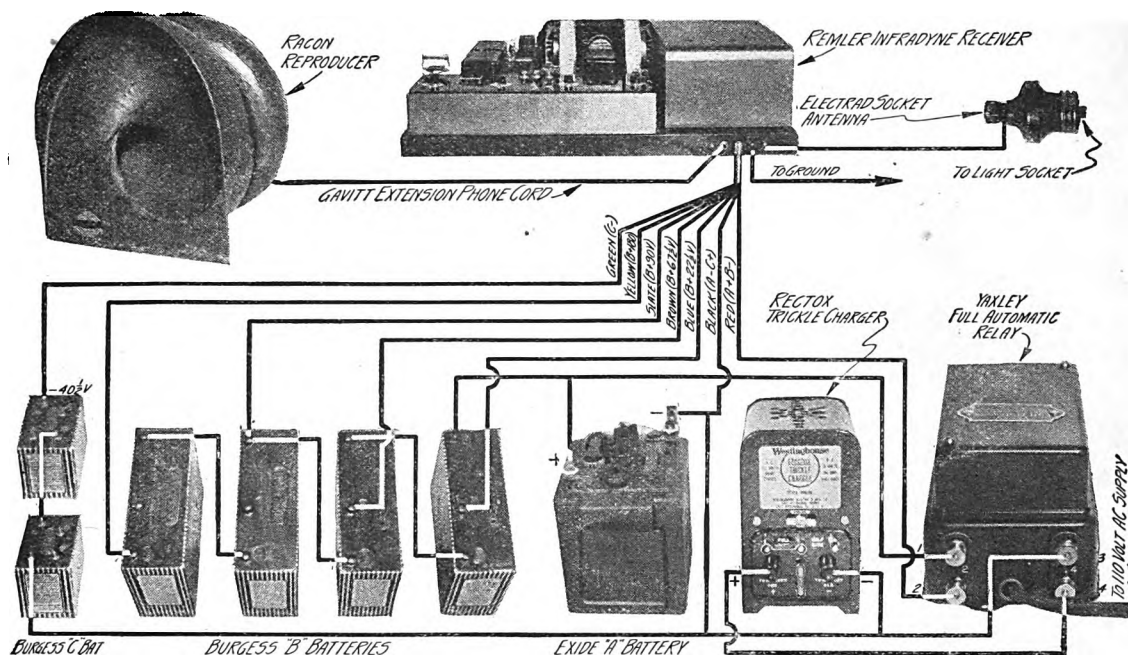
The next work to be done is to prepare the cable harness and the battery cable. Cut about four inches of the outside covering from one end of the battery cable, Z, and fifteen inches from the other end; wrap binding cords around the ends to keep them from fraying. Pass the ends of the cable having the four-inch leads through the terminal strip, X, from the outside and cut the individual wires the correct lengths for connection to the terminal blocks in accordance with the picture wiring diagram in Figure 2.

Now we are ready to build up the cable harness. With the foundation kit is supplied a full size sheet which is reproduced in Figure 7. On the lower part of this diagram are small numbered circles. Procure a flat, soft-wood board about ten inches wide and two feet long. The full size template should be placed on top of this board and nails driven in part of the way through each of the numbered circles.

At the top of the template are ten detailed drawings, each for a wire of different color. These detailed drawings are numbered from one to ten, inclusive. Cut the separate wires of the correct length, following the detailed drawings in natural sequence, laying out, in each case, the wire of the color called for. When all of the wires have been placed in position and twisted around the nails, as shown in Figure 7, they may be tied together with cord, using the form of knot known as the "half

FIGURE 4: THE SCHEMATIC WIRING DIAGRAM OF THE RECEIVER.





HOW TO HOOK UP THE RECEIVER

FIGURE 5: All the connections between the receiver and the "A," "B" and "C" supplies, as well as the reproducer, ground and antenna, are shown in BLACK lines. For ordinary local reception, without the use of the infradyne amplifier, it will be found that the current drain is very low.

hitch." In tying the cable be particularly careful to make the hitches at all branches, starting at the upper left-hand corner.

The cable harness can now be put into the bottom of the pressed steel base and the various leads soldered to the terminals of the units mounted under the chassis. In making these connections refer to the picture wiring diagram in Figure 2. Figure 3 also shows these connections and the holes through which a number of them are to be passed up to the top side of the set.

The connections to the various instru-

ments and terminals on the top side of the receiver should be made in accordance with the picture diagram shown in Figure 2.

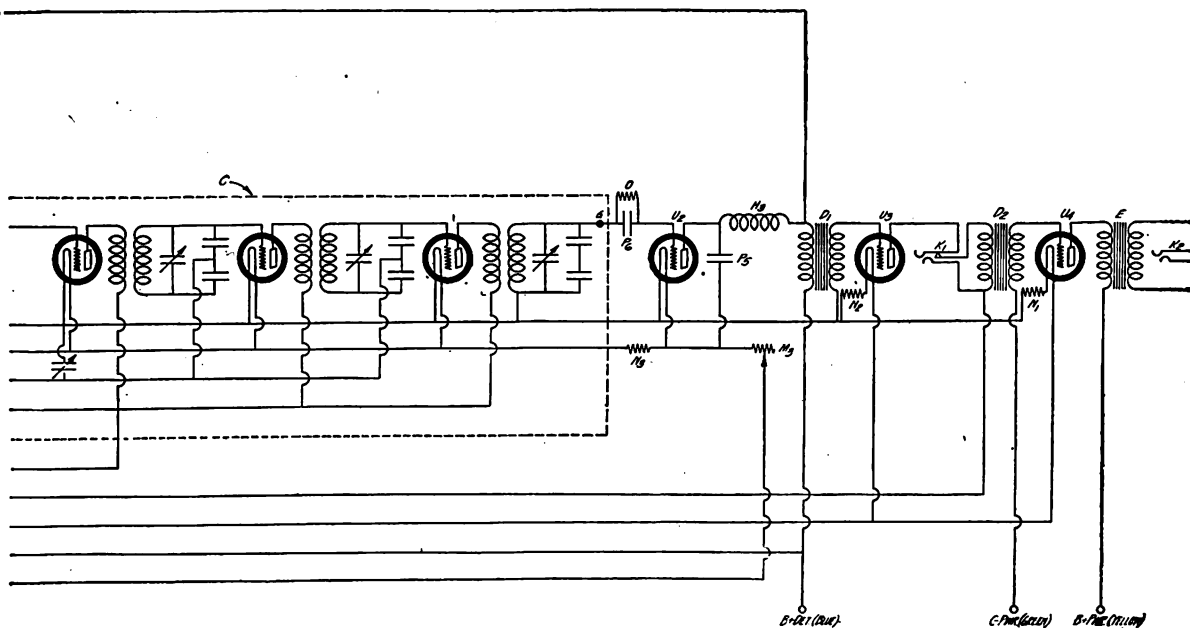
Packed with the foundation kit is an instruction booklet and full size blue prints showing the exact connection for each colored wire. These should be followed explicitly and checked with the picture wiring diagram shown in Figure 2.

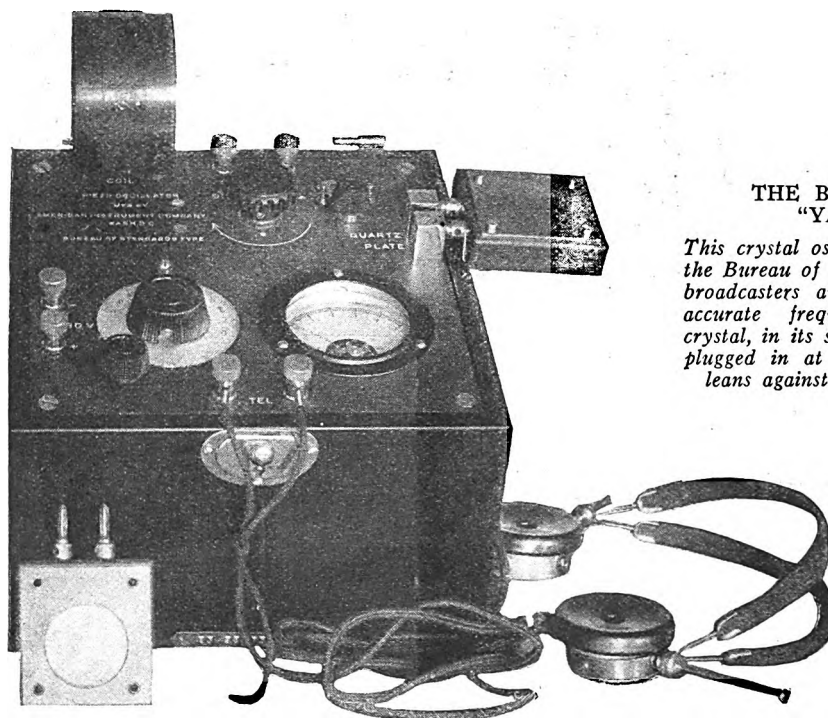
When the wiring has been completed the set is ready for installation and may be fastened to the wooden base, G2, and the set is ready for operation.

How to Install and Operate the Set

We are now ready to install the vacuum valves and to put the set into operation. Remove the top from the amplifier, A, and insert three CX-301-a type valves and replace the metal top. Next place three CX-299 type valves in the socket of the infradyne amplifier, C, and in the socket located in the steel chassis immediately below and back of the voltmeter. This is designated in Figure 1 as socket U1. Place two CX-301-a type valves in

(Continued on page 340)





THE BROADCASTER'S "YARDSTICK"

This crystal oscillator was designed by the Bureau of Standards to be used by broadcasters and experimenters as an accurate frequency standard. One crystal, in its square case, may be seen plugged in at the right, and another leans against the front of the box.

Finding The "Yardsticks" of Radio At the Bureau of Standards*

By DR. J. H. DELLINGER
Chief of the Radio Staff
U. S. Bureau of Standards

OF all the kinds of work upon which the Bureau of Standards is engaged, none has more absorbing interest or more direct value to the public than the researches of the radio section. To an extent little realized by the average man, progress in radio is a direct result of the application of scientific knowledge and methods. Radio waves are so elusive and the signals they carry so delicate that they can be handled only by means of scientific instruments of high sensitivity and precision. The ordinary processes of touching, seeing, or measuring are useless, for the most part. The reader can perhaps appreciate this when he considers that radio waves and currents are alternating at the rate of a million or more times per second.

While it may not be easy to understand what makes the radio wheels go round, it is easy to see how the work of this Bureau is helping to make radio a more obedient and efficient servant of mankind. Here is a list of some of the things that Uncle Sam

Tasks which vary from the designing of condensers to investigation of the cause of fading come within the great work which the radio section of the United States Bureau of Standards is carrying on for the advancement of radio. Here is the story of how our Government's skilled staff of experts has solved or is solving many of radio's most baffling puzzles.

has accomplished through the work of the Bureau's Radio Laboratory:

1. Developed the radio beacon and radio direction finder, the only reliance of ships in fog;
2. Demonstrated the practicability of using radio for broadcasting music, market reports, etc.;
3. Devised the first and only practical means of radio communica-

- tion with submerged submarines;
4. Devised the directive beacon, capacity altimeter, and other aids to airplane navigation;
5. Made surveys to determine distance range of broadcasting stations, effects of interference, etc.;
6. Designed the straight-line-frequency condenser;
7. Reduced the heterodyne interference between broadcast stations through special work on frequency measurements and standards;
8. Worked out the explanation of fading, night radio transmission through the upper air, etc., forming basis of present-day theories;
9. Made scientific studies of antennas, coils, and many of the other components of radio apparatus, giving the basis for much present-day radio design;
10. Published treatises on many radio subjects.

Some of the Bureau's present activities in radio are:

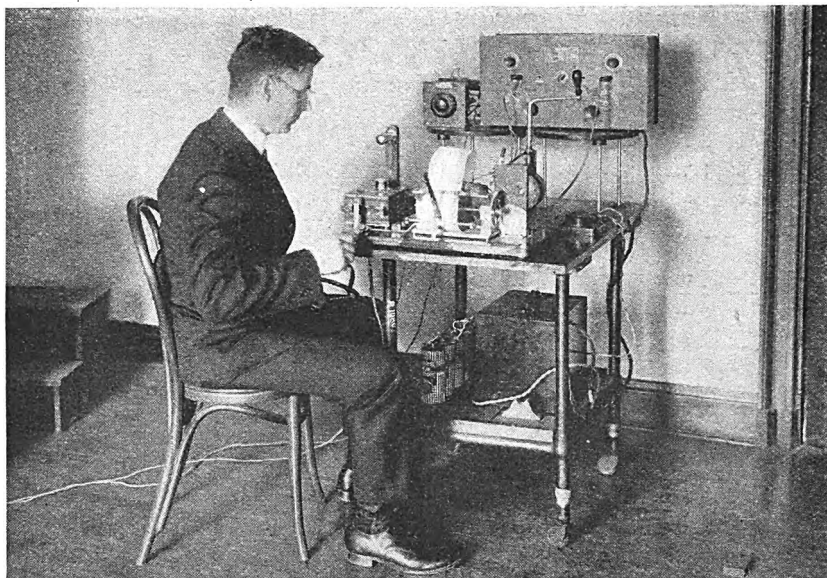
1. Reduction of interference be-

* Publication approved by the Director of the Bureau of Standards of the United States Department of Commerce.

tween broadcasting stations by design and standardization of special devices for holding them on the licensed frequency;

2. Determination of the actual capacity of stations to give service and to cause interference, through development of apparatus for measuring their radiation at a distance;
3. Development of piezo-electric and other frequency standards of great precision;
4. Studies of the vagaries of radio wave transmission, fading, static, etc., in co-operation with other laboratories;
5. Dissemination of frequency standards, by standard frequency signals;
6. Studies of radio measurement methods, design, etc.;
7. Improvements in radio direction finders;
8. Development of radio aids to aviation, including radio telephony, beacon system, and landing devices.

The Bureau's radio section is only one of eighty sections in this great institution having a total personnel of 900. The radio section has twenty scientific workers, one draftsman and four mechanics. In addition to maintaining its own radio laboratory, the Bureau co-operates with the National Research Council in the maintenance of a group



FADING SIGNALS WRITE THEIR STORY

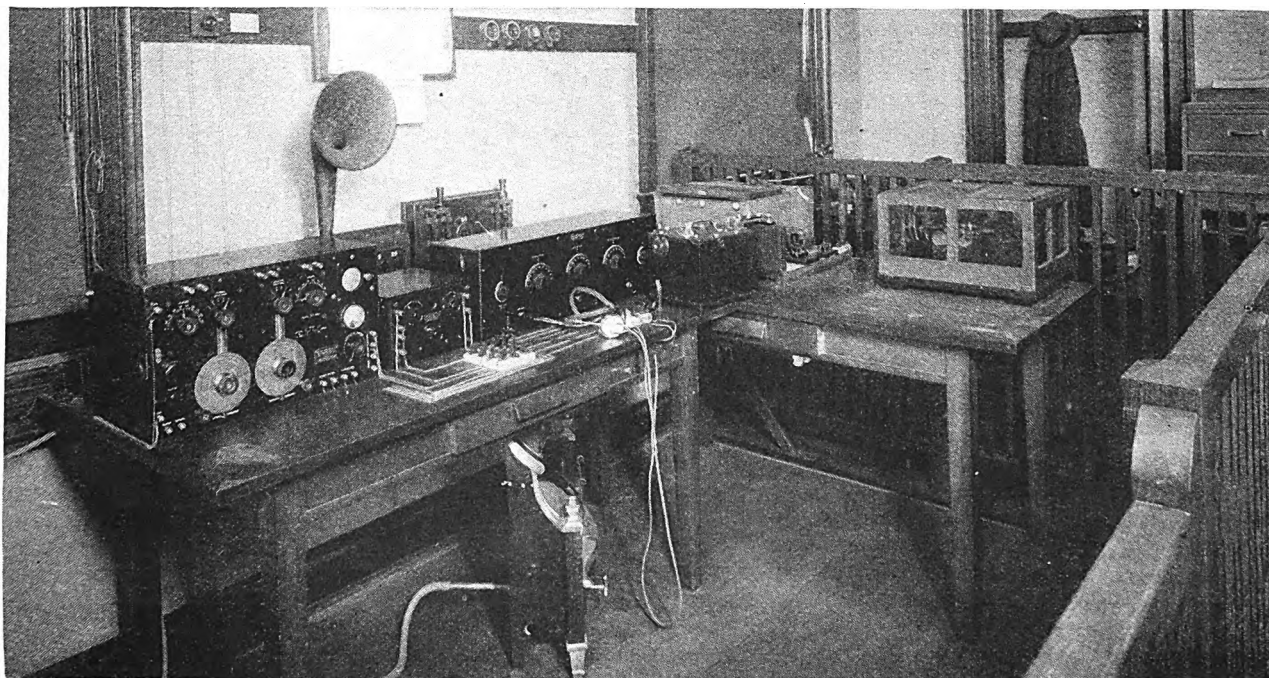
The recording apparatus shown above enables Bureau of Standards investigators to get a permanent record of the fading of signals received by the set on the back of the table. Careful study of these records is of great value in determining the exact cause of this baffling phenomenon.

of three workers on special radio transmission problems, and also provides facilities for a small laboratory which the Signal Corps maintains at the Bureau.

Radio broadcasting as it now is, has come as the fruition of many years of scientific research, inventive genius, and commercial development. The question, "Who invented broadcasting?"

is much like the old question, "Who won the war?" The Bureau of Standards enters no claims in this debate, but it has been steadily identified with the developments which have established the present broadcasting service. In 1920, at the request of the Department of Agriculture, the Bureau ran, for four

(Continued on page 336)



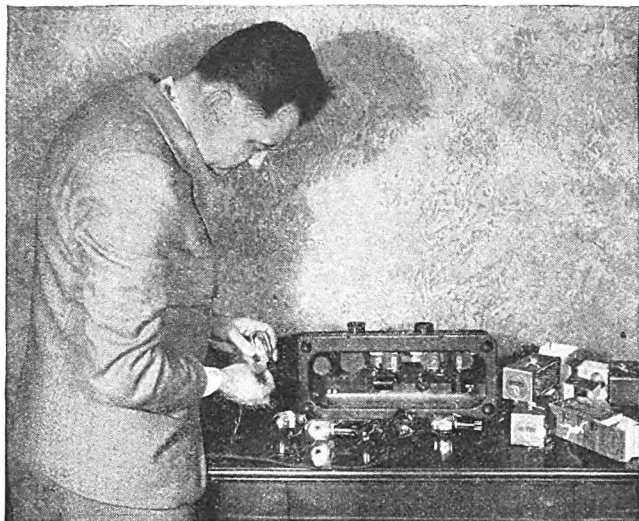
Bureau of Standards

KEEPING TABS ON THE WAVE JUMPER

This receiving apparatus is used by the Bureau of Standards in determining the frequencies of broadcasting stations. In the days when wave jumping was more prevalent than at present, the Department published a monthly honor list of stations which stuck to their assigned frequencies.

From Battery to Socket—Quick!

No matter how old your DC receiver may be, it can be brought right up to the minute with this AC kit. Only four principal operations are involved in bringing about the change. If you take your time, ten minutes may be required. If you are in a hurry, only one minute may be spent on each operation. The four pictures on this page illustrate the operations involved in the conversion of the DC Atwater-Kent five-valve receiver.



HARNESSING UP THE VALVES

1 THE first operation involved in the change to AC operation is to remove the DC valves. The connector clips of the harness are then slipped onto the special heater terminals of the new Marathon valves. These valves operate direct from AC current, so there is no need to be concerned about the polarity of the connectors.



CONNECTING THE HEATER TRANSFORMER

2 AFTER the valves are connected to the harness and inserted in the sockets, the two connector clips left at the end of the harness are brought to the filament heater transformer of the kit. There is no need to pay attention to polarity. The core lead on the heater transformer is then connected to the receiver ground.



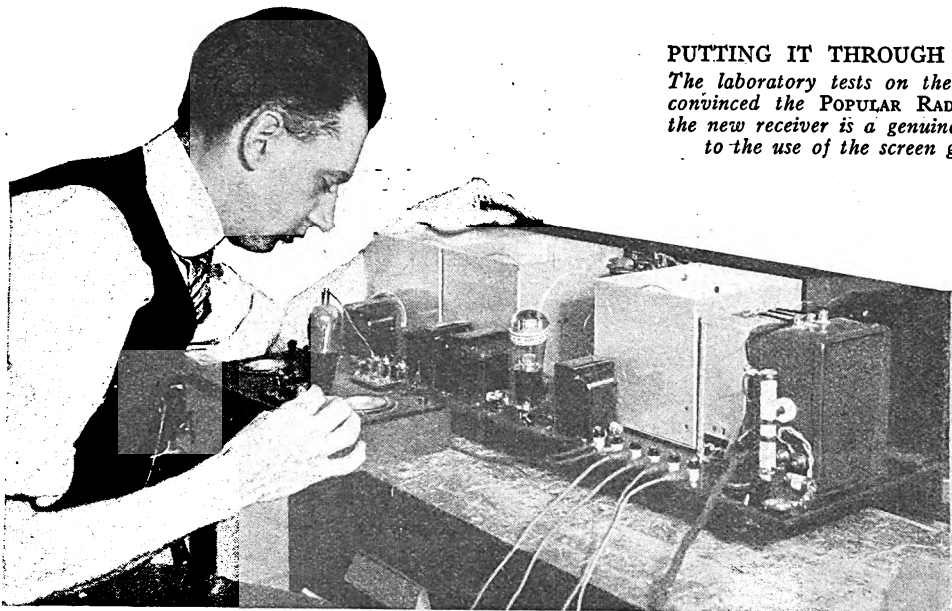
A NEW WAY OF CONTROLLING VOLUME

3 SINCE it is impossible to use rheostats on the heaters of AC valves, volume is controlled by a potentiometer. One side of this potentiometer is connected to the aerial and the other side to the ground of the receiver being converted. The filament rheostat of the receiver is no longer used to control the volume.



SNAP THE SWITCH AND TUNE IN!

4 THE transformer supplied with the Marathon kit is provided with a switch which breaks the primary current of the filament transformer. This is used in place of the filament switch on the receiver. After turning the transformer on, about twenty seconds will elapse before the valves are ready for operation.



PUTTING IT THROUGH ITS PACES

The laboratory tests on the QSA-5 have convinced the POPULAR RADIO Staff that the new receiver is a genuine contribution to the use of the screen grid valve.

The Screen Grid Valve Finds a New Job in the QSA-5 Receiver

In the new Thordarson QSA-5 receiver screen grid valves are used not only in the high-frequency amplifier, but in the low-frequency as well—a new departure in circuit design that should interest every experimenter and fan. In this descriptive article the reader will see that this new use is not an attempt at a “trick” circuit, but constitutes a real advance in modern receiver engineering.

By G. P. STEWART

THE hours which have been spent in overcoming the effects of internal feedback through three-element vacuum valves can never be counted. Undesired oscillation, which has been the most noticeable effect, has remained the chief foe of amplification since the adoption of tuned-high-frequency stages ahead of the detector. This particular difficulty has recently been eliminated almost completely by the addition of a simple screen located within the valve. This screen or shield so reduces the effective internal capacity that the remaining feedback is negligible, and we find the four-element vacuum valve, now commonly called the screen grid valve, opening many opportunities for change in our previous notions of circuit design.

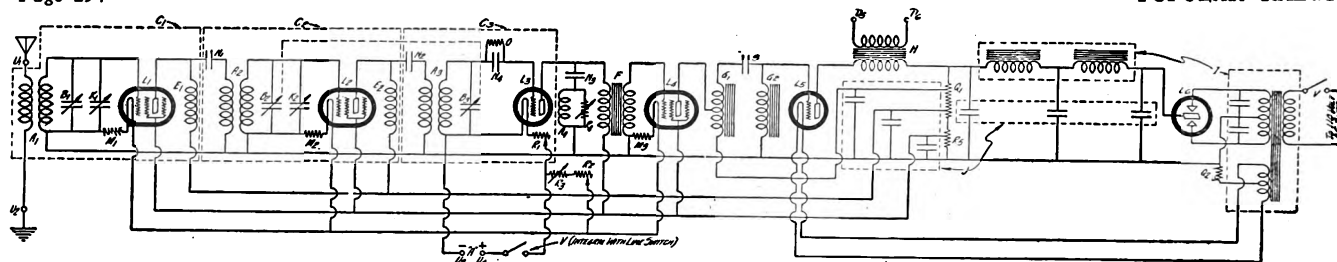
In designing the QSA-5 receiver, which will be described in detail in the next issue of this magazine, four things were sought for. The first was a degree of selectivity which would allow reception of distant stations with the receiver placed in a congested district.

The second requirement was sensitivity sufficient to allow reception of these distant stations with volume enough to make listening a pleasure rather than an achievement. The third requirement was fidelity of tone and the fourth was a total cost within a reasonable limit, considering the results obtained. In passing, it may be mentioned that the letters “QSA” form the radio code abbreviation for “Your signals are strong.”

The desired solution for the QSA-5 receiver was found in the coupling method shown in Figure 1. Voltage is applied in the high-frequency amplifier to the valve's plate through a choke coil of high impedance which carries the direct current for the plate supply. The path for the high-frequency current is completed through another part of the plate circuit which includes a coupling condenser and the primary winding of a high-frequency transformer, the secondary of this transformer being tuned with the usual variable condenser. The primary winding consists

of forty turns, closely coupled to the secondary. Since no high-voltage direct current enters any part of the transformer, it is possible to ground one end of the primary winding, one end of the secondary and one side of the tuning condenser.

Amplification or sensitivity, with the new screen grid valve, depends chiefly on the impedance introduced into its plate circuit. The arrangement adopted in the QSA-5 does not introduce the maximum possible impedance, but does introduce a very high impedance considering the selectivity attained. High-frequency current in the plate circuit has a choice between two paths, one the choke coil and the other the tuned transformer. The choke coil offers great opposition, forcing most of the high-frequency current through the transformer. The close coupling between primary and secondary, combined with the fact that the secondary is tuned, has much the same effect as a tuned plate circuit in this path, and satisfactory amplification results.



THE SCHEMATIC DIAGRAM OF THE QSA-5 CIRCUIT

FIGURE 1: The screen grid valves are used in the two high-frequency stages and in the first low-frequency stage. The second low-frequency stage employs a power valve of the 371 type. At the right of the diagram is the power supply incorporated in the receiver.

As may be seen from Figure 2 and the schematic diagram in Figure 1, the receiver includes a high-frequency amplifying system, a low-frequency amplifying system and a complete plate power supply, all mounted upon the one sub-panel and arranged for housing in a cabinet of standard dimensions. Screen grid valves are put to use both in the high-frequency amplifier and in the low-frequency amplifier.

Screen grid valves are used in both the high-frequency stages. For a detector it is possible to use either the usual CX-301-a type of valve, one of the special gas-content detectors, or a power valve of the 312 type. In the first stage of low-frequency amplification another screen grid valve is used, and the final stage is fitted with a power valve of the 371 type.

The Operating Controls

Tuning is accomplished by means of a double-drum dial. The left-hand part of the dial operates the tuning condenser, B1, in the antenna stage. The right-hand part of the dial operates the remaining two tuning condensers, B2 and B3, which are connected together through a flexible coupling. The two tuning condensers, B1 and B2, nearest the dial, are each provided with parallel-connected adjustable condensers, K1 and K2, of small capacity. The small condenser, K1, for the first stage allows the two halves of the dial to operate approximately together over a large

part of the scale. The small condenser, K2, for the second stage, allows the capacity in this circuit to be matched with that in the detector circuit so that these two circuits are both in resonance to the same frequency at a given setting.

In any receiver there is a natural and inherent gain in amplification at the higher frequencies or lower wavelengths. This is due chiefly to the greater impedance and greater voltages in all circuits at high frequencies. In order to allow uniform volume at all dial settings it is necessary either to increase that naturally available at low frequencies or else to decrease that naturally available at high frequencies. Both methods are employed in the QSA receiver by fitting two separate controls which may be used together or independently.

One control is a simple rheostat which reduces the filament temperature of the screen grid valves. The volume may be raised and lowered by means of this control, but it is impossible to produce oscillation with it. The second control provides a limited degree of regeneration in the detector stage. The high-frequency current in the plate circuit of the detector valve is carried through a fixed condenser, N3, to a coil, A4, having inductance sufficient to produce regeneration even at the lower frequencies. This action is due to the detector being provided with what amounts to a tuned plate circuit, or with sufficient inductance in its plate circuit to cause a feedback through this valve. The

amount of feedback and the consequent regeneration are controlled by a variable resistance, R4, mounted on the front panel and connected across the ends of the plate coil, A4. The rheostat control, R3, is on the left-hand side of the front panel and the regeneration control knob, R4, is on the right. The rheostat, R3, is the only control needed for nearby stations and for all stations below about "50" on the tuning dials. For distant stations, tuned in at higher dial settings, the right-hand regeneration control, R4, may be used.

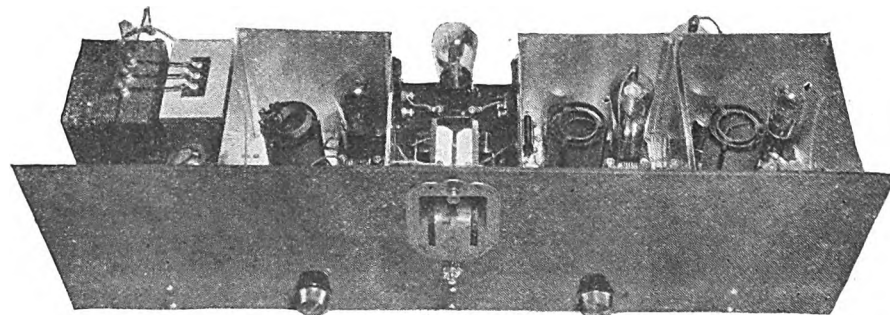
The Low-Frequency Amplifier

The low-frequency amplifying system utilizes transformer coupling between the detector and the first low-frequency amplifying valve, which is of the screen grid type. The plate circuit of this screen grid valve is connected to an autoformer, G1, which provides a step-up type of impedance coupling. A second autoformer, G2, here acting as a straight impedance, is placed in the grid circuit of the power valve, this impedance replacing the grid-leak ordinarily employed with impedance amplification. The output of the power valve passes through the primary of a coupling transformer, H, of which the secondary is connected to the reproducer.

The coupling used between the screen grid low-frequency valve and the power valve is rather unusual. The current in the plate circuit of this screen grid valve first builds up a voltage across part of the winding of the autoformer. This winding is in two sections so that there is a step-up effect and the magnified voltage is applied to the grid of the power valve through a coupling condenser of a capacity unusually large for this work.

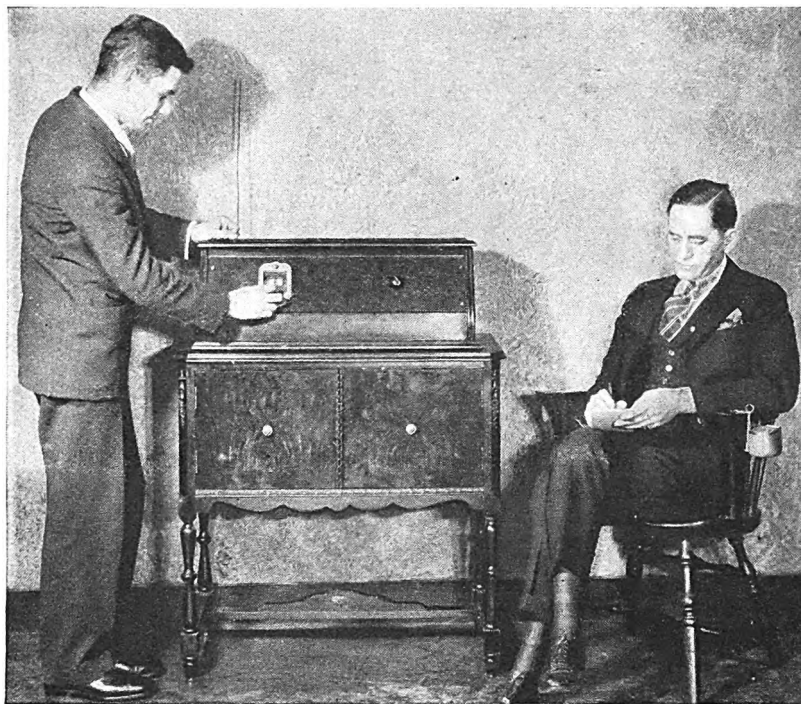
The high-voltage amplification of the screen grid valve was found to be very favorable in its effect on the 371 type of power valve, which is able to handle considerable changes of grid voltage when given a correspondingly great grid bias. With the type of grid circuit usually employed with the autoformer

(Continued on page 324)



HOW THE INSTRUMENTS ARE ARRANGED

FIGURE 2: The layout of parts in the new receiver is particularly attractive and workmanlike. Complete shielding is employed for the high-frequency stage and the detector. The power supply is shown at the left end of the panel.



SUPREME IN DX

The 15-inch wire by the left hand of the man at the left is the antenna with which this model of the LC-28 brought in the stations on the West Coast.

A New Standard for the Distance Hunter! The Screen Grid LC-28

The combining of the virtues of the standard LC-28 with the new features of the screen grid valve offers the builder and fan a unique opportunity for constructing a set that incorporates the finest in power, quality, ease of operation and distance-getting ability. And it is quite simple to construct the new model described here, or to convert the standard set for the use of screen grid valves.

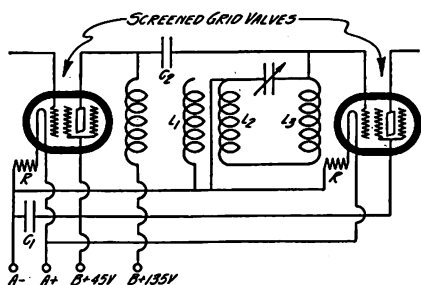
By LAURENCE M. COCKADAY

ABOUT the time that the author was experimenting with the original model of the LC-28 receiver, the Laboratory procured a number of the British type of four-element valves, now more commonly known as screen grid valves. A few weeks of experiment with this type of valve convinced the engineers in the Laboratory that this was a long step ahead of the three-element valve for high-frequency amplification work because much higher amplification could be obtained with the newer type.

Set builders and experimenters will remember the circuit details of the LC-28 receiver incorporated the use of a shunt-plate-feed arrangement, supplying the amplified currents out of the valves into a primary coil inductively-coupled to a secondary tuning coil.

It was decided during the earlier

periods of experimentation to use the same coils, tuning and shielding arrangement for the four-element valves, the only radical change being that the primaries of the coils would be left unused and the amplified current would be

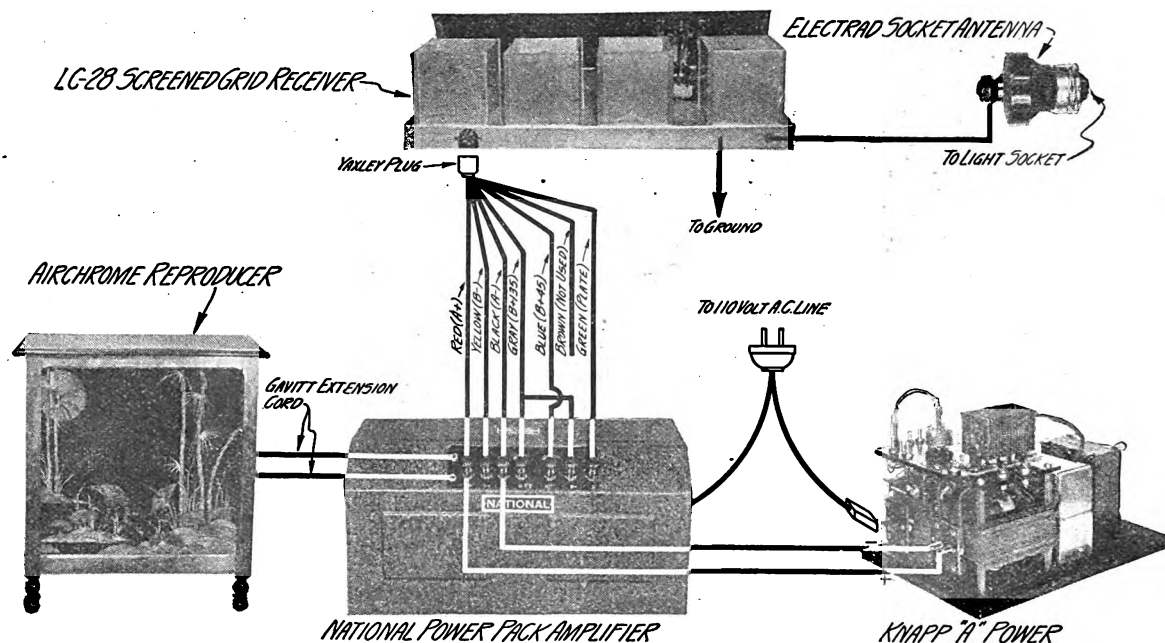


THE CIRCUIT CHANGES

FIGURE 1: This diagram shows how the circuits of the high-frequency stages of the LC-28 are modified for the use of screen grid valve amplification.

impressed directly onto the secondary coils. This arrangement is shown in the small schematic diagram in Figure 1. In this diagram a positive potential of 45 volts is applied to the secondary grids which are by-passed with a fixed condenser, C1, to the filament circuit. The coupling condenser, C2, is decreased in capacity and coupled directly to the secondary coils, L2 and L3. The primary coil, L1, is left disconnected. The filament resistors, R, are increased in value so that the proper bias is obtained by the voltage drop in these resistors. These are the only really radical changes in the circuit.

When the American valves appeared on the market, it was a simple matter to revise the LC-28 circuit so that they should be utilized in the receiver to greatly enhance the value of amplification obtained in each stage. Whereas



HOW TO HOOK UP THE NEW LC-28

FIGURE 2: The operating hook-up shown here has been found to give exceptional results. As explained in the text, the antenna may be an ordinary wire about two or three feet in length. For extreme distance, however, an outdoor antenna is recommended.

a value of voltage amplification of approximately 10 per stage is secured with standard valves, the newer type screen grid valves, employing the circuit outlined, produces a voltage amplification of approximately 40 per stage, so that an outdoor antenna may be done away with. Antennas of from four inches to ten or fifteen feet long give ample results in distance reception, according to the location.

With the receiver wired up and reconstructed, as shown in Figures 3 and 4 and the picture wiring diagram in Figure 5, reception, on a six foot antenna, of signals three and four thousand miles distant is a regular occurrence, and is thoroughly enjoyable provided the static level is not too high at the time of reception.

The receiver incorporating the new valves is not at all difficult to construct

and, it is believed, gives to the set builder a standard design that exemplifies the most modern ideas in high-frequency amplification and tuning combined in any broadcast receiver.

How to Make the Change

The mechanical changes necessary in the receiver are few and simple. The three high-frequency amplifier sockets should be replaced with the sub-chassis type of socket, as shown in Figures 3 and 4. Also, the three original filament resistors of four ohms each are to be replaced by the resistor units, I1, I2 and I3, all ten ohms each. The coupling condensers, K1, K2 and K3, are replaced with new coupling condensers of .00005 mfd. each. The rheostat, S, is replaced with a new combination switch and rheostat of ten ohms and an added fixed resistor of four ohms is placed in

the common filament circuit of the three high-frequency amplifier valves. The by-pass condenser, G, of .25 mfd. is added to by-pass the high-frequency current from the screening grid to the filament circuit.

One more addition, a Hammarlund equalizing condenser, should be attached to the first tuning condenser, J1, to balance it up so that its dial reading will match the dial readings of the other three condensers.

It will be advisable, when assembling the screen grid model of the LC-28, to obtain a copy of the October, 1927, issue of POPULAR RADIO for further constructional details.

How to Wire the Instruments.

The picture wiring diagram in Figure 5 gives the exact wiring details in connecting up the receiver for screen grid operation in the high-frequency amplifier stages. The wiring of this circuit to the Yaxley plug and cable is specifically made to be operated in conjunction with the National resistance-coupled power amplifier which will furnish all of the plate voltages necessary for the converted receiver, as well as the screening-grid voltage that is necessary with the new type valves.

It is recommended that the set builder follow these details in wiring conscientiously, and that he check them carefully before the set is placed in operation.

It will be noticed that the connection to the control grid is made to the
(Continued on page 334)

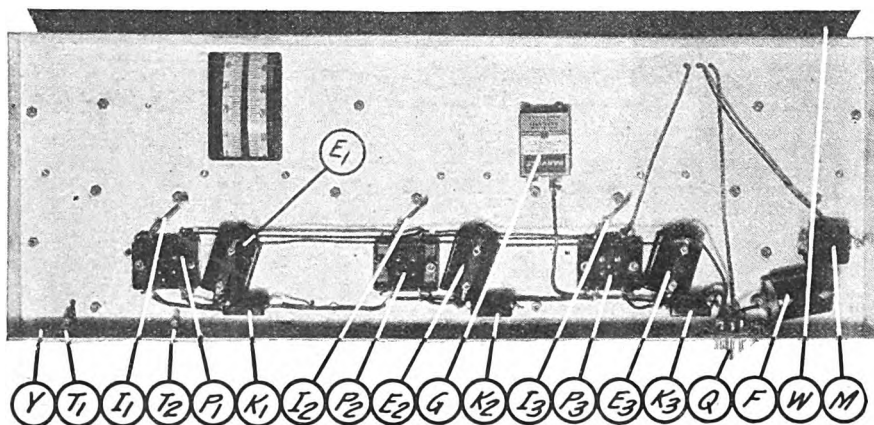


FIGURE 3: THE UNDER SIDE OF THE SUB-PANEL

POPULAR RADIO WORK SHEET

THE SCREEN GRID LC-28

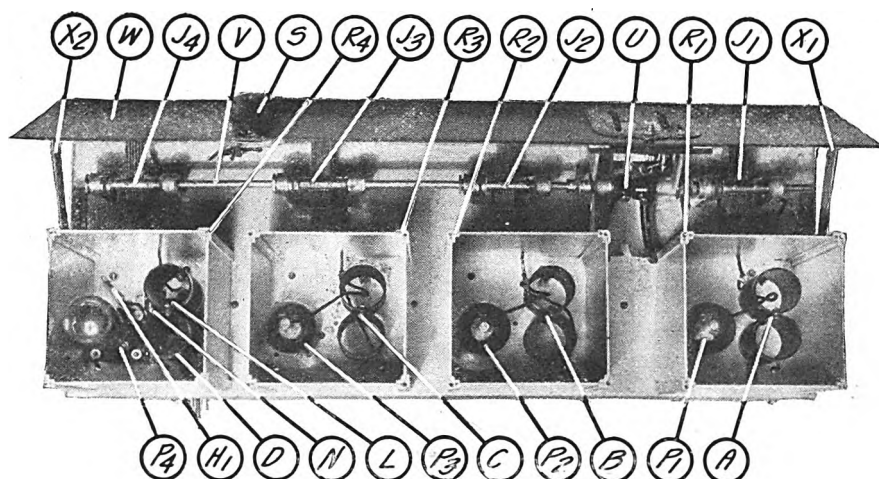


FIGURE 3: THE RECEIVER VIEWED FROM ABOVE.

LIST OF PARTS USED IN BUILDING THIS RECEIVER

COST OF PARTS—Not over \$83.00

- | | | |
|---|--|--|
| A, B, C and D—Precision high-frequency transformers (4 transformers), type 4-B; | L—Aerovox moulded condenser, .00025 mfd.; | T1 and T2—Carter "Imp" plugs and tip jacks, marked <i>Antenna</i> and <i>Ground</i> , respectively, with insulating washers for the antenna; |
| E1 to E3—Samson high-frequency chokes, type No. 125; | M—Aerovox moulded condenser, .00075 mfd.; | U—Hammarlund double-drum dial; |
| F—Samson high-frequency choke, type No. 85; | N—Durham metallized resistor, 6 meg-ohms; | V—Brass extension shaft, 16½ inches long and ¼ inch in diameter; |
| G—Acme Parvult by-pass condenser, ¼ mfd., Series A; | O—Hammarlund equalizer; | W—Aluminum panel, 6 by 26 inches, drilled and decorated, made by the Wholesale Radio Service Company; |
| H1 and H2—Yaxley resistance units, 4 ohms, type No. 804; | P1 to P3—Remler sockets, No. 50; | X1 and X2—Tait brackets; |
| I1 to I3—Yaxley resistance units, 10 ohms, type No. 810; | P4—Benjamin vibrationless socket, No. 9040; | Y—Aluminum chassis for the LC-28, made by the Aluminum Company of America; |
| J1 to J4—Hammarlund mid-line variable condensers, .000275 mfd.; | Q—Yaxley cable connector plug with cable, type 660; | Z—Lynch single-resistance mounting; |
| K1 to K3—Aerovox moulded condensers, .00005 mfd.; | R1 to R4—Special small size aluminum box shields for LC-28, made by the Aluminum Company of America; | Hook-up wire, mounting bolts and nuts, solder, etc. |
| | S—Yaxley combination switch and rheostat, 10 ohms, type No. 910-K; | |

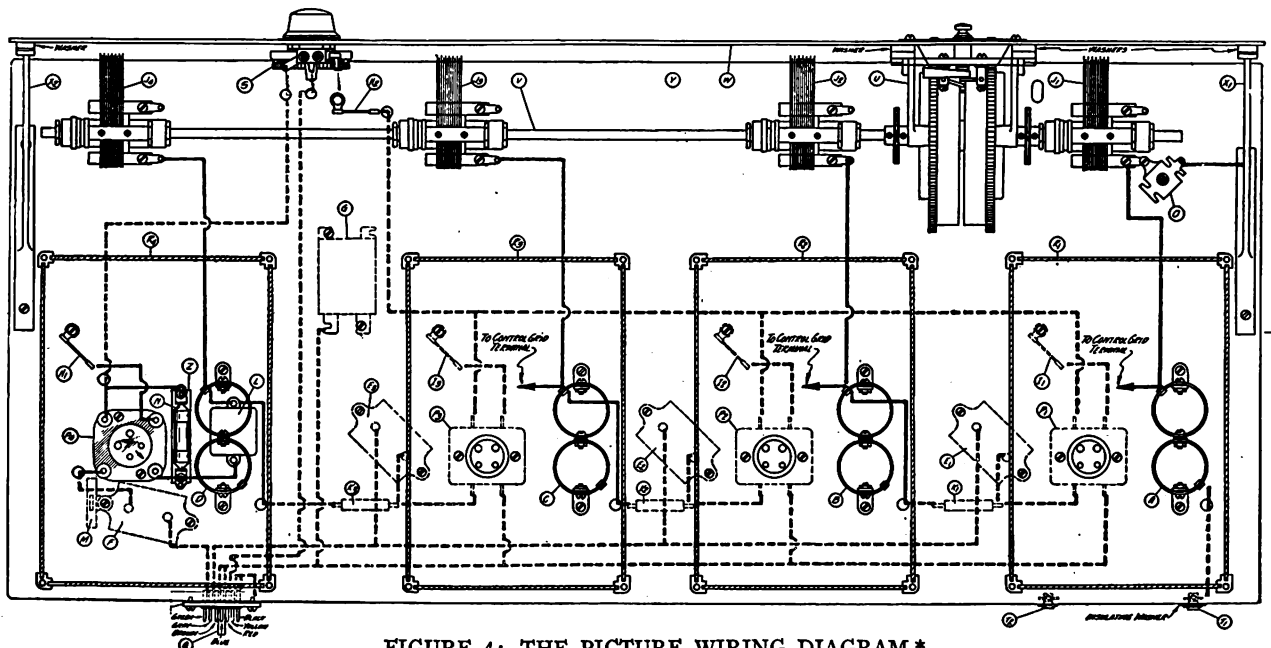


FIGURE 4: THE PICTURE WIRING DIAGRAM.*

* Through error the above diagram omits a connection from the P terminal of socket P4 to one lug of condenser M. The other lug of the condenser is grounded by screwing it to the chassis.

RADIO PUTS ITS "EYES" TO USE

This picture shows part of the apparatus used in a recent demonstration of the radio transmission of pictures. The motor in the foreground revolves the cylinder on which the picture to be transmitted is placed, thus exposing every part of the picture to the photo-electric cell.



National Broadcasting Co.

How the Photo-electric cell is used for

The "Eye" of Television

No up-to-date follower of the progress of radio can afford to be ignorant of the principles which underlie the operation of radio's newest aid in wonder working, the photo-electric cell. The theory of photo-electric action, and its relation to modern ideas of light and atomic structure, are here explained with such clarity that the mystery which has surrounded this phenomenon is completely dispelled.

Article No. 2

By DR. LEWIS KOLLER
Research Laboratory, General Electric Company

THE story of the development of the photo-electric cell, from the experiments of Hallwachs, in 1888, to the potassium and cesium cells of today, was told in the March, 1928, number of POPULAR RADIO. It would be interesting now to consider these modern cells from a theoretical point of view, and show how their action is in accord with modern theories of electricity and atomic structure.

It is a very interesting fact that the number of electrons which are emitted from the sensitive surface of a cell depends upon the intensity of the light,

but that the velocity with which they are shot out from the surface depends only on the color of the light and is entirely independent of the intensity. This fact is explained by the quantum theory of the nature of light.

The quantum theory postulates that light energy cannot be indefinitely subdivided, but exists in definite units called quanta. In other words, light has a granular or atomic structure. The size of each of these units, or rather the energy of each quantum, is equal to a universal constant, h , times the frequency of the light. The higher the

frequency, accordingly, the more energy is associated with the quantum.

According to this theory, each quantum of energy will cause the emission of one and only one electron. The velocity of that electron will depend upon the kind of quantum, that is, on the frequency of the radiation.

The phenomena of photo-electricity furnish strong evidence in favor of the quantum theory. A simple calculation will show that when the light from a one-candlepower source at a distance of one meter falls upon 1 sq. cm. of a photo-sensitive surface, each atom of

that surface receives an amount of energy equivalent to 10^{-22} watts/sec.

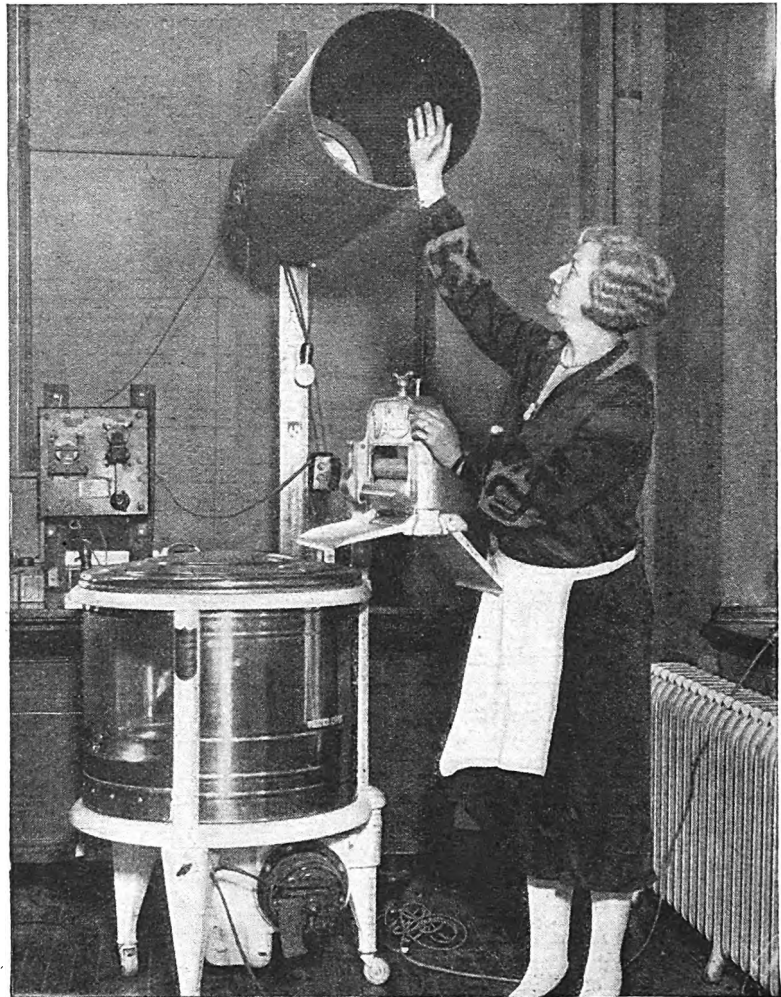
The energy which is necessary to free one electron is 4×10^{-19} watts/sec. In order to accumulate sufficient energy at this rate to free an electron if the light fell uniformly over the surface, it would have to fall on the surface for over an hour. We know, however, that the photo-electric effect is instantaneous and that the current starts the instant the light is allowed to fall on the photo-sensitive surface.

The explanation of the discrepancy is that the light does not fall uniformly over the surface, as would be the case if the old wave theory of light were true, but is concentrated in these quantum units, each of which causes the ejection of an electron.

Of course, these photo-currents are small, so that in order to avoid the necessity for using high sensitivity instruments amplification is resorted to. This may be done by means of vacuum valves, as in radio work; but there is also a method of amplification within the photo-electric cell itself which is of great value. This method makes use of the ionization of gases. For this purpose, after the cell has been exhausted, gas at a very low pressure is introduced. This pressure ranges from .02 mm. of mercury in some of the larger types of cells to 1 mm. in the very smallest cells. The gas used must not react with the sensitive cell surface and it must also not "clean up" or disappear during the life of the tube. The gases which satisfy these requirements are the rare gases of the atmosphere, and of these argon, neon and helium are the most frequently used.

The theory of the part played by the gases is as follows:

When light falls upon the sensitive cell surface, electrons are emitted and are drawn towards the anode, due to its positive potential. Some of these



P. & A.

STARTING MACHINERY WITH A BEAM OF LIGHT

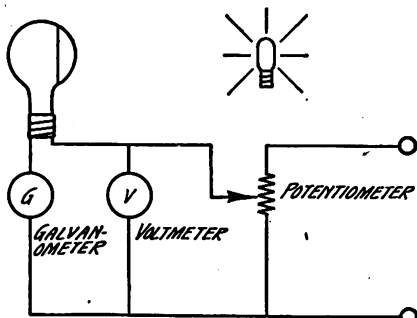
This picture gives some idea of the sensitiveness of the response of a photo-electric cell to small changes in light intensity. The shadow of demonstrator's hand falling upon a cell within the large cylinder causes a change in current which starts the electric washing machine.

electrons naturally will chance to collide with gas molecules. As a matter of fact, at a pressure of .02 mm. there are 7×10^{14} gas molecules in each cubic centimeter of space. Calculations show that an electron traveling through a gas at this pressure will make two collisions in each centimeter of its path, on the average. It is the consequence of these collisions that is of interest. The collision may be of the same type as when two rubber balls come together. They will fly apart again, perhaps moving in different directions and at different speeds than before, but otherwise unchanged. Such a collision is of no use in producing amplification. On the other hand, a collision may take place with disastrous consequences to the gas molecule.

When a collision of the second kind takes place the photo-electron actually knocks one of the electrons in the outermost orbit completely out of the gas

molecule, thus ionizing it. The result is that instead of the original electron and a neutral molecule we have two electrons moving over to the positive electrode, and the remainder of the gas molecule, which is now positively charged and is called a positive ion, moving towards the cathode. We have thus multiplied the original charge threefold. There is still the possibility of the two electrons making still more collisions before they reach their destination. This is no violation of the law of the conservation of energy, because the energy required is drawn from the battery across the cell terminals. The result of this process is that for each electron which the action of the light liberates at the surface of the cathode we may have several arriving at the anode of the photo-electric cell.

Since the flow of electrons constitutes the current, the gas may be said to amplify the photo-current internally.



HOW THE CELL CHARACTERISTICS ARE DETERMINED

FIGURE 1: The set-up shown here is used for the determination of the volt-ampere characteristics of a cell such as are shown in the charts in Figures 2 and 3.

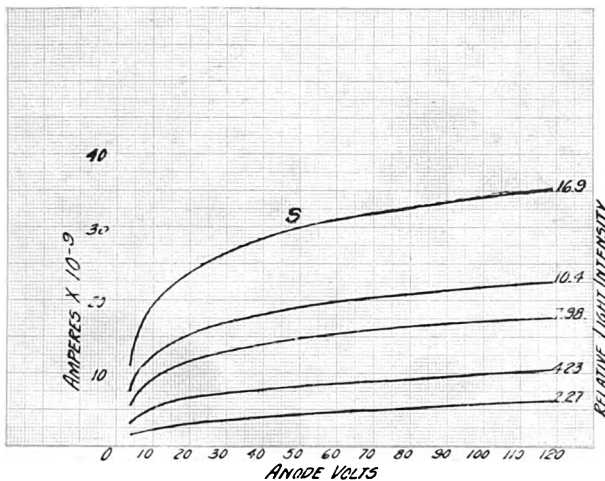


FIGURE 2: VOLT-AMPERE CURVES FOR A VACUUM PHOTO-ELECTRIC CELL.

The amount of amplification obtainable in this fashion depends on the nature of the gas, the intensity of the light source, the construction of the cell, and the voltage applied across the cell.

The relation between the voltage applied to the cell and the current through it, called the "volt-ampere characteristic," is of great use in determining operating conditions. Such data is obtained by means of the set-up shown in Figure 1. The voltage is varied by means of the potentiometer, and the current through the cell is read on the galvanometer. Such curves can be obtained for different conditions of illumination by moving the light nearer to, or farther away, from the cell.

Figure 2 shows a family of such characteristics for a vacuum photo-electric cell. The lowest curve is for a very weak illumination. It will be seen that at low potentials the current

rises rapidly with the voltage. The current, of course, is simply a measure of the number of electrons which reach the anode. At first sight, this variable current would seem to be inconsistent with the fact that the number of electrons set free from the cathode depends only upon the intensity of the incident light. The apparent inconsistency is due to the fact that at low voltages all of the emitted electrons do not reach the anode. As the voltage is increased, a larger proportion of them reach their goal, and at the point where the voltage is high enough to draw over all the emitted electrons. That is why further increases in voltage do not produce any further change in current and the curve continues as a straight, horizontal line. The voltage which is necessary to draw over all the electrons is called the saturation voltage. In order that the current may be a real

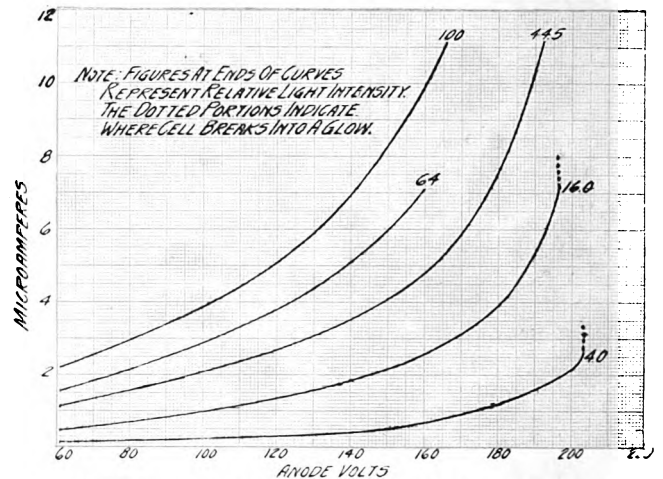
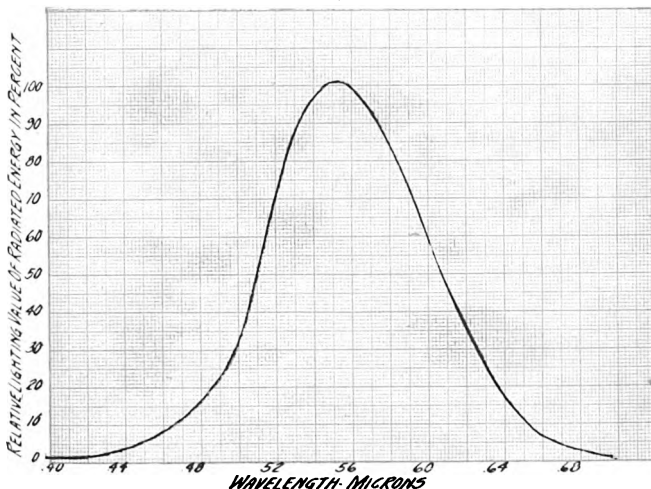


FIGURE 3: VOLT-AMPERE CURVES FOR A GAS-FILLED PHOTO-ELECTRIC CELL.

measure of the light intensity, the voltage must always be above the saturation voltage. If the light intensity is now increased, a curve is obtained of the same shape as before, but the saturation value is higher to correspond to the new value of light intensity.

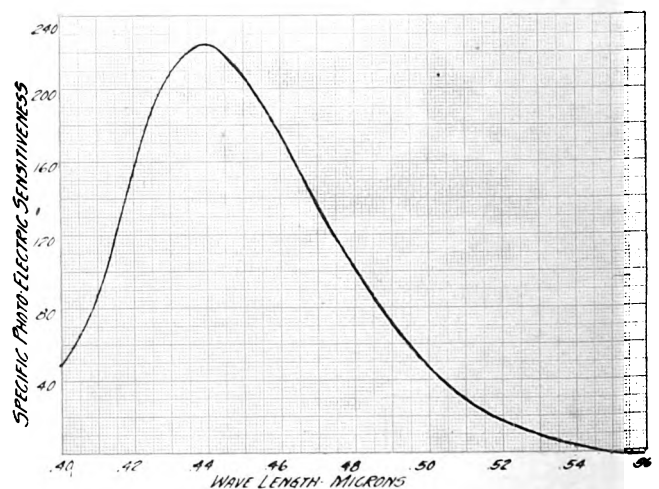
In the case of gas-filled cells, the curves are radically different in form, as is shown in Figure 3. As soon as a definite voltage called the ionization voltage is exceeded, some gas molecules become ionized. As the voltage is increased, still more ions are produced, so that instead of being flat, as in the case of the vacuum cell, the curve of current against voltage continues to rise. Eventually this curve becomes quite steep and the cell breaks into a glow.

It has been stated that the current through a photo-electric cell is directly
(Continued on page 348)



HOW THE HUMAN EYE RESPONDS TO COLOR

FIGURE 4: This curve shows the relative sensitiveness of the human eye to the light spectrum. The band of greatest sensitiveness lies between 54 and 58 microns, or green light. Outside this band the response of the eye drops.

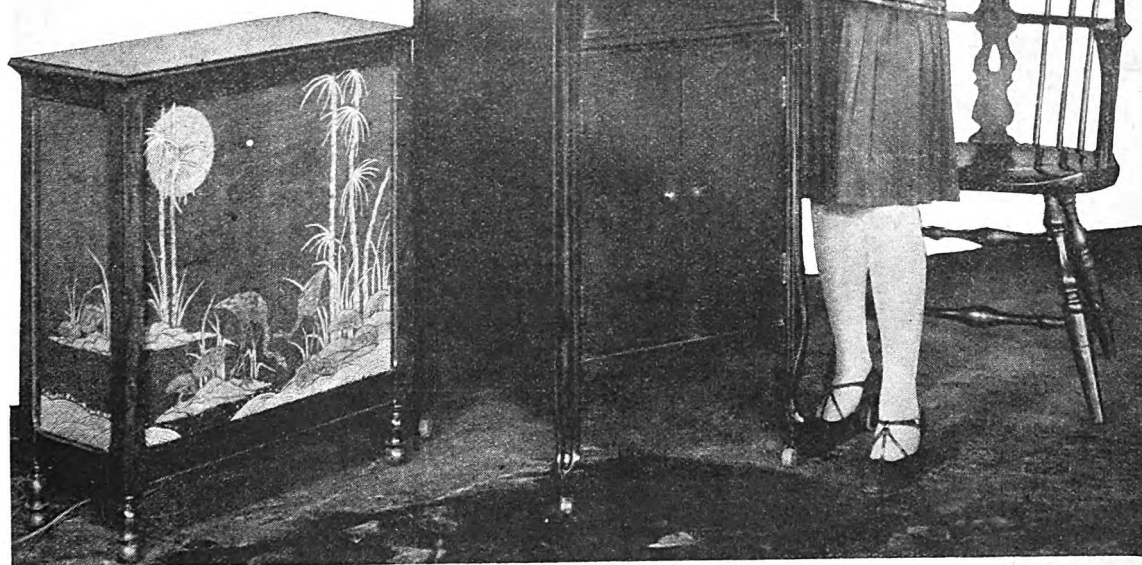


HOW THE ELECTRIC EYE RESPONDS TO COLOR

FIGURE 5: A comparison of this curve with that in Figure 3 shows how photo-electric "sight" differs from human sight. The potassium cell whose curve is shown here is most sensitive to light in the violet-blue portion of the spectrum.

The Phonograph's New Lease on Life

Radio principles of reproduction have so rejuvenated the phonograph art that even people who do not own radio sets are clamoring for radio amplifiers for their old phonograph. The details given in this article tell exactly how to wire and install the electrical units for obtaining radio-quality reproduction from any old phonograph. The model converted in the POPULAR RADIO laboratory is shown at the right.



1928 Reproduction from a 1910 Phonograph

By MORRIS M. SILVER

THERE have been described in POPULAR RADIO, during the past nine months, various methods whereby old phonographs may be rejuvenated by using radio amplification and an electrical pick-up with a radio reproducer, so that a great improvement in reproduction will be possible.

All of these articles, however, have dealt with the electrical apparatus and circuits and the different combinations or complete systems for accomplishing these results. The judgment of the reader has been relied on for the actual assembly of the apparatus in a phonograph.

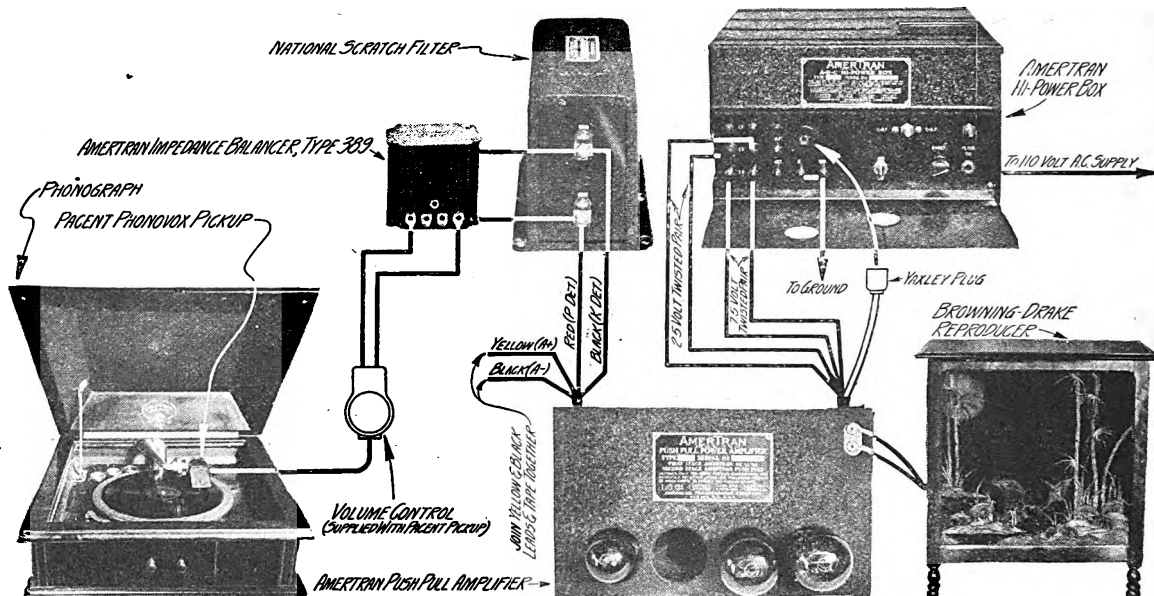
There have been so many letters received, however, during the last few months, for specific information in con-

verting various types of old phonographs that the laboratory has taken one of the more popular models and installed in it a complete amplification and reproduction system. The model is one of the vertical cabinet type, with a spring motor and turntable located under the lifting lid. Directly under this, in front, is a shutter arrangement for the horn, and underneath this are two folding doors opening outward upon a shelved compartment for holding phonograph records.

After considering the type of apparatus that would be used it was decided to place it, in bulk, in the shelved record compartment, and leave the horn compartment untouched, although the horn was not to be used.

How to Make the Installation

First of all, the mechanical tone chamber is removed and replaced with a Pacent Phonovox electrical pick-up, which attaches to the tone arm with a set screw. The cord on the pick-up unit should be threaded down through the metal tone arm and past the point where the metal of the horn joins the wood; there a hole should be drilled and the cord pulled through the top side of the wooden portion of the horn into the space between the horn and the cabinet itself. Then the volume control, which is furnished with the Phonovox, is placed in a convenient position in one of the corners, not occupied by the turntable, and three holes drilled in the wooden top shelf of the



HOW TO HOOK UP THE INSTRUMENTS

FIGURE 1: The amplifier, the high-power box, the impedance balancer and the scratch filter are all placed in the lower part of the console cabinet of the phonograph. The reproducer should preferably be placed on the opposite side of the room. All the connections between these instruments are here shown in heavy black lines.

phonograph for the three terminals and cords on the volume control. Two connections are in the cord from the Phonovox. The connections themselves are clearly shown in the photo-diagram

in Figure 1. The remaining cord of the volume control is fed down through holes drilled in the partitions to the lower compartment that holds the phonograph records.

The next job is to remove the two front side strips holding the shelving in place in the record compartment and to take out all of the shelves except one, which is the fourth from the bottom. This may be slipped out and turned around so that the curved cut-out faces the rear of the cabinet and may be used for passing the connection wires. Then the two side strips may be replaced.

The installation chosen for this phonograph is similar to that shown in the February, 1928, issue of POPULAR RADIO, except that a scratch filter has been added for eliminating from the final reproduction the noise of the needle passing over the record.

The AmerTran high-power box is installed in the lower portion of the record compartment with the switch and front panel turned to the front, while the AmerTran push-pull amplifier is installed in the rear portion of the top shelf that has been left in the compartment. The National scratch filter is screwed down to the front part of the shelf, and the AmerTran equalizer is placed alongside it. All of these instruments are to be connected up as shown in the photo-diagram in Figure 1. Figure 2 shows how the instruments are arranged in the record compartment. The ground wire and the reproducer cord and the extension cord and plug (to be run to the 110 volt 60 cycle lighting lines) are brought out through holes in the rear of the cabinet. The AC extension cord and the exten-

(Continued on page 330)



HOW THE AMPLIFIER IS PLACED IN THE CABINET

FIGURE 2: The high-power box is placed in the lower part of the cabinet of the phonograph, while the amplifier, the needle-scratch filter, and the impedance balancer are placed on one of the shelves that formerly held the records. The other record shelves are taken out to make room for the instruments.

Running the Musical Scale With the New SPN Speaker



The enormous advance in low-frequency amplification methods has made the old-fashioned reproducer entirely inadequate. Among the new reproducers that have been designed for use with high-power amplifiers the SPN speaker stands well in the front. The unit is able to handle, without distortion, the output of the most powerful 210 or 250 amplifier.

By FRANCIS D. BUSHNELL

arranged in a push-pull stage. The output current during the test ran as high as 49 milliamperes, with voltage on the lower end of the frequency range varying between 1,000 and 1,280. The speaker performed remarkably well with this great load and was free not only from standing waves, but from harmonic distortion as well.

The driving motor of the SPN speaker is exceptionally massive and is able to handle large amounts of energy with ease. The field of the driving motor is supplied with four large permanent magnets of the usual horseshoe shape. Careful tests showed that this unit was able to carry high power at very low frequencies.

Those who have made a study of reproducer operation are aware that a large part of the distortion is due to resonance; that is, of excessive vibrations at particular frequencies. These resonance points of a reproducer cause it to over-emphasize certain frequencies at the expense of others. In many instances harshness is caused at the high frequencies and unpleasant drumminess at the low frequencies. There is loss of sharpness in definition which causes sort of a hangover effect, permitting one note to blend or overlap into another. The SPN speaker has had such intrusion guarded against by the designing of a special suspension method so as to neutralize the vibrations reflected at the edge of the cone. The design is so arranged so as to make use of the relative phase-shifting occurring at forced and free boundaries. This does not cause a loss of energy from the use of damping devices.

THE attainment of quality in reproducers involves many intricate problems of acoustics that are not generally understood by laymen. The characteristics of a loudspeaker might be entirely upset by some trivial change in its design. The thickness of the quality of paper forming the diaphragm, for instance, has a most important bearing upon the sound frequencies to which a speaker will respond. The quality of the magnets in the driving motor, or the length of the driving rod, all have important bearings. Yet with all of these confusing details, sound physicists have, during the past two years, made great strides in the perfection of speakers that will accommodate not only great power, but will respond to sound frequencies as low or as high as those that will be passed by the average low-frequency transformer.

POPULAR RADIO has in the past several months given its readers the details of all the principal developments in reproduction, ranging from exponential horns to balanced-tension speakers. There is still another development which has won its place in the esteem of the laboratory staff and which would seem to mark still another improvement in sound reproducing devices. This is the

SPN speaker, a gigantic cone in oval form, measuring 30 inches across its widest point, with a height of 44 inches. There is scientific justification in employing this particular form of cone. It has been found that this shape will accommodate both the lower and the higher audible frequencies, due to the wide variation in its diameter that exists between the narrowest and widest points.

The SPN speaker employs what is technically known as a free-edge cone. In this case, however, perhaps the term "semi-free edge" would be more accurate, inasmuch as the edges of the cone are laced to the oval wood frame which encircles the cone.

The rod of the driving motor is so attached that the cone can be moved either backward or forward by simply adjusting a thumb nut. Adjustment at this point is important, and the user of the device will find that by sliding the cone backward and forward on the driving rod a certain point will be reached where the device will reproduce at maximum efficiency.

During tests that were conducted in the POPULAR RADIO laboratory, it was found that this cone could easily take an output of two 210 amplifier valves



COUNTERFONIC RECEPTION WITHOUT BATTERIES

Installed in its Corbett cabinet, and hooked to the AC lighting lines, the Counterfonic makes as good an appearance as much more expensive sets, and gives reception fully commensurate with the cost of building it.

AC-izing the Counterfonic

With the demand for socket operation sweeping the country, it is quite natural that fans should be demanding an AC model of so popular a set as the Counterfonic "Six." Here are all the data for making the simple changes in the old receiver and building a small power-pack, which will make the Counterfonic a completely batteryless job—as told by the originator of the circuit himself—

KENNETH HARKNESS

SET BUILDERS who constructed the earlier models of the Harkness Counterfonic "Six" receiver have had such good results, at an economical expenditure for the complete set, that many letters have been received inquiring whether the receiver can be operated on alternating current, without batteries.

The advantages of AC operation in eliminating operating expense and service work are well known to all radio fans. With these advantages in view, during the past two months many experiments have been made with various power units by means of which the desired result might be accomplished.

The power unit to be described in this article is the one that gave the results which have been most thoroughly

satisfactory. The cost for parts is relatively little and the construction is simple. Only a few changes are necessary in the receiver itself for the efficient use of AC valves receiving their operating voltages from the new power-pack.

The new power-pack utilizes a standard Raytheon BH type rectifier valve, operating in conjunction with a power transformer, a heater transformer for supplying the AC heater voltages for the AC valves, and a simple filter circuit for obtaining the correct "B" voltages for the set. When used with the receiver, in conjunction with AC valves, more power can be obtained from the set, as well as an added improvement in quality of reproduction.

How to Change the Receiver for AC Operation

The first job will be to re-wire part of the receiver to accommodate the AC valves. Refer to the picture wiring diagram in Figure 2, the top view in Figure 1, and the bottom view in Figure 3 while making the changes for light-socket operation.

First remove all of the filament-circuit wiring from the "A" negative (—) and "A" positive (+) binding posts through the filament switch and the resistors to the filament terminals of the valve sockets. Also disconnect the wiring to the pilot light.

Next take out all the grid-return wiring, that is, the wiring connected to

POPULAR RADIO WORK SHEET

THE AC COUNTERFONIC SIX

LIST OF PARTS FOR BUILDING
THIS RECEIVER

COST OF PARTS—Not over \$73.00

- A, B and C—Harkness Counterfonic high-frequency transformers;
 D1, D2 and D3—Cylindrical copper shields;
 E1, E2 and E3—Harkness tuned double-impedance audio-couplers for the first, second and third stages;
 F—Harkness audio-output-filter unit;
 G—Harkness high-frequency choke coil;
 H1 and H2—Aerovox moulded by-pass condensers, 1 mfd., type 250;
 I—Silver-Marshall drum dial;
 J1 and J2—Harkness brackets;
 K1, K2 and K3—U. S. L. three-gang variable condenser, .00035 mfd. capacity in each condenser section;
 L—Westinghouse Micarta drilled sub-panel with 5 sockets attached;
 M1—Carter midget potentiometer, 500 ohms, type MW-500;
 M2—Carter adjustable resistor, 10 ohms, type AP-10;
 N—Carter Imp battery switch;
 O1—Carter center-tapped resistor, 40 ohms, type CU-40;

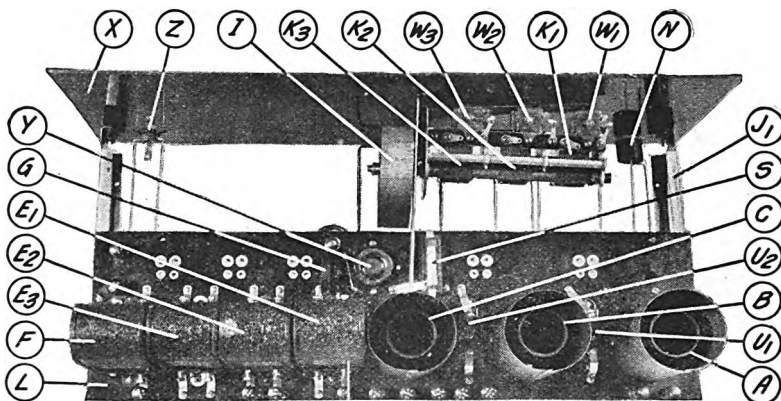


FIGURE 1: THE AC RECEIVER FROM ABOVE

- O2—Carter center-tapped resistor, 10 ohms, type CU-10;
 O3—Carter fixed resistor, 1,500 ohms, type H;
 P—Aerovox fixed condenser, .0001 mfd.;
 Q—Aerovox fixed condenser, .00025 mfd.;
 R—Aerovox fixed condenser, .001 mfd.;
 S—Lynch grid-leak, 2 megohms;
 T—Lynch grid-leak mounting;
 U1 and U2—XL neutralizing condensers, .0001 mfd., Model G-5;
 V1 to V13—Eby binding posts;
 W1 to W3—Hammarlund equalizers;
 X—Westinghouse Micarta drilled and engraved front panel;
 Y3—Eby UY 5-prong socket;
 Z—Carter "short" jack, open circuit, type No. 1;
 Wire, screws, solder, etc.

LIST OF PARTS FOR BUILDING THE COUNTERFONIC POWER-PACK

COST OF PARTS—Not over \$43.00

- A—Silver-Marshall power transformer, type No. 329-A;
 B—Silver-Marshall unichoke, type No. 331;
 C—Aerovox buffer condenser, .1 mfd. and .1 mfd., center tapped, type No. 646;
 D—Aerovox filter condenser block, type BH-420;
 E—Aerovox moulded by-pass condenser, 1 mfd., type 250;
 F—Aerovox Pyrohm tapped resistor, 13,000 ohms, type 994-171;
 G—Eby UX socket;
 H1 to H11—Eby binding posts;
 I—Wooden baseboard, 17 by 4 by ½ inch;
 J—Micarta binding-post strip, 11½ by ¾ by 3/16 inch;
 K1 and K2—Binding-post strip brackets, 2 inches high by ½ inch wide.

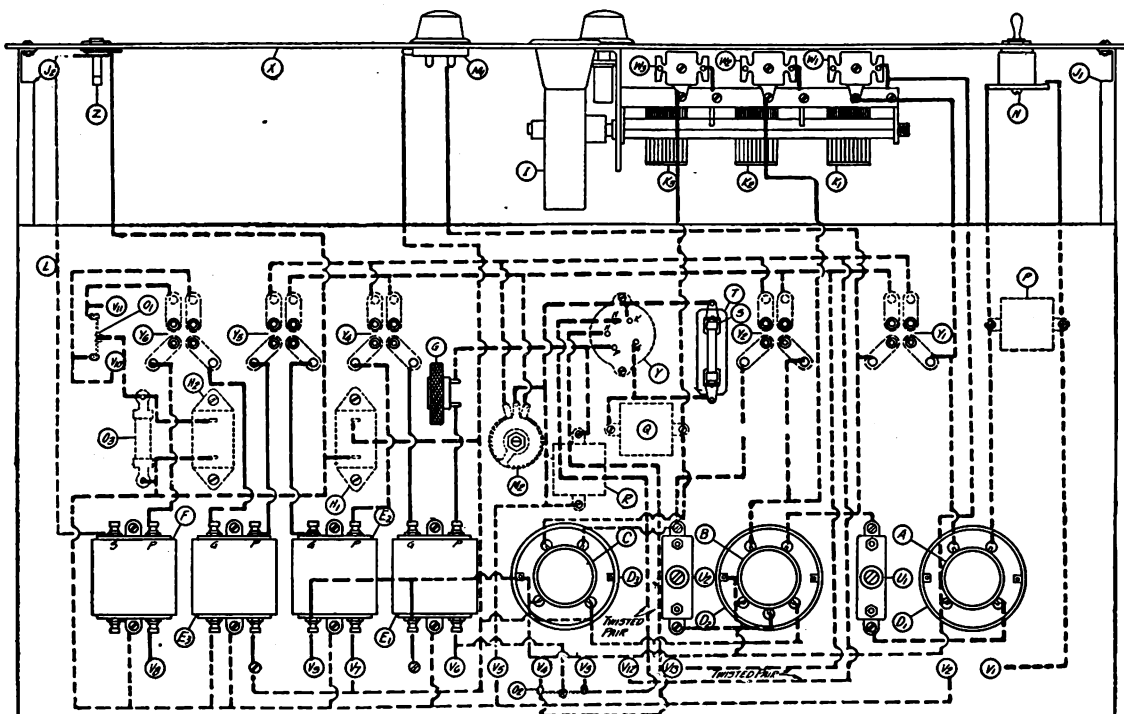
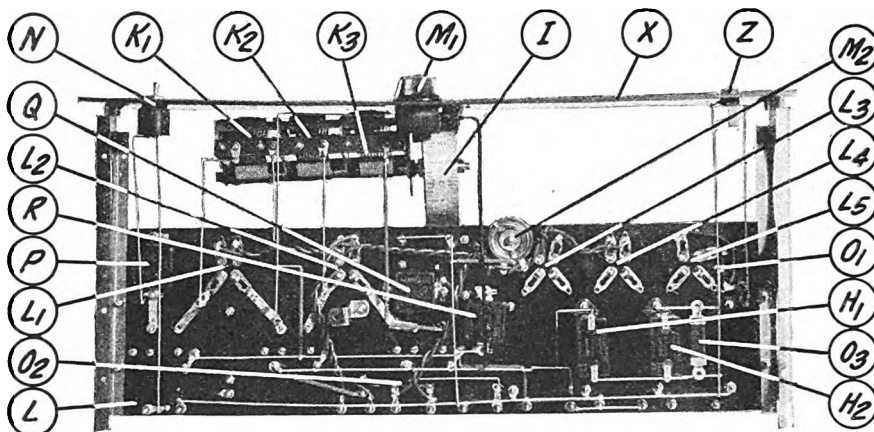


FIGURE 2: THE PICTURE WIRING DIAGRAM



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 3: Notice the twisted cables for the filament circuits of the AC valves, which replace the bus bar wiring of the DC model of the receiver. Most of the additional parts necessary for AC operation are mounted under the sub-panel, and are shown above.

the "F" terminals of the double impedances and the corresponding terminals of the high-frequency transformers.

Then remove the "B" negative (—) wiring including the connections to the various fixed condensers, the grid-leak, the reproducer binding post and the instrument case grounds. Take out the connection from the output filter to the other reproducer binding post. Remove the filament rheostat and replace it with the Carter midget potentiometer, M1.

Remove the detector socket by drilling a hole sufficiently large to insert the top of an Eby 5-prong socket. The large hole may be made by drilling a series of small connecting holes around a circle of the correct size and filing the edges smooth after knocking out the center. Insert the 5-prong socket under the sub-panel with the cathode and one heater terminal at the front of the set and fasten with brass machine screws and nuts to the sub-panel.

Now mount the Carter adjustable resistor, M2, under the sub-panel between the detector and the first low-frequency socket. Remove the filament switch and replace it with the Carter jack, Z. Install an additional Aerovox by-pass condenser, H2, under the sub-panel.

Insert new binding posts as are shown to be necessary according to the picture wiring diagram in Figure 2.

The new wiring can now be started. Connect the grid and plate terminals of the 5-prong detector socket to the same instruments to which the corresponding terminals of the DC detector socket were connected. Figure 2 shows the correct wiring for the unit.

Connect the two 2½-volt AC binding posts to the filament terminals of sockets one, two, four and five, and to the two outside terminals of the Carter adjustable resistor, M2. Use a twisted pair of wires for all AC filament wiring.

The two 2½-volt AC binding posts are connected to the heater terminals of socket Y. Also connect the Carter

center-tapped 10-ohm resistor, O2, directly across the same AC binding posts and connect the mid-point of this resistor to the "B" 45-volt positive (+) binding post.

The two 5-volt AC binding posts should be connected to the filament terminals of socket six and to the pilot light. Also connect the Carter center-tapped 40-ohm resistor, O1, directly across these AC binding posts. Connect the mid-point of this resistor to one side of the Aerovox by-pass condenser, H2, and to one end of the Carter 1500-ohm fixed resistor, O3.

Now connect the "B" negative (—) binding post to the ground binding post, the cathode terminal of the detector socket, the grid-leak, S, the pointer of the Carter adjustable resistor, M2, the Aerovox fixed condenser, R, the by-pass condensers, H1 and H2, the Carter fixed resistor, O3, the "F" terminal of the third double impedance, E3, the frame terminal of the Carter jack, Z, the cases of all the double impedances and the output unit.

Connect the open terminal of the output unit, F, to the remaining terminal of the jack, Z.

Connect the "C" negative (—) binding post to the "F" terminals of the first two double impedances, to the "F" terminals of the three high-frequency transformers and to the frame of the triple condenser.

The necessary changes for light-socket operation of the receiver have now been completed.

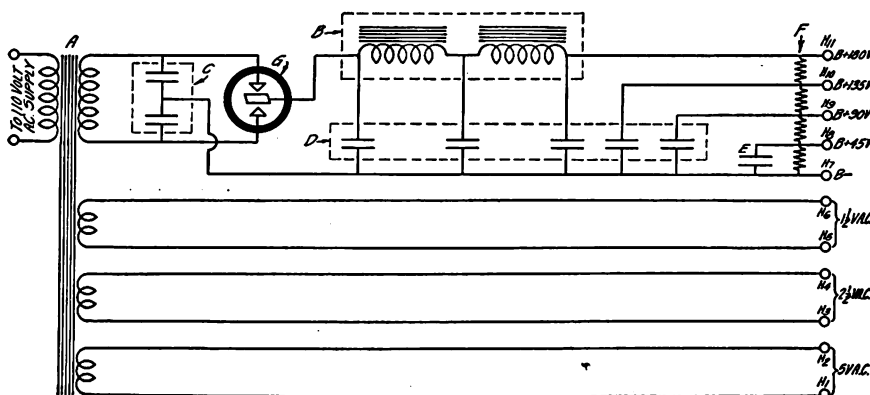
How to Build the AC Power-Pack for the Receiver

Refer to the circuit wiring diagram in Figure 4 and the top view in Figure 6 for the details of construction.

First mount the binding posts on the Micarta binding-post strip. Note that the "B" battery negative (—), 45-volt positive (+), 90-volt positive (+), 135-volt positive (+) and "B" positive (+) power binding posts are exactly opposite the first, third, fourth, fifth and sixth terminals of the Aerovox resistor, F. When the resistor is mounted, the lugs on it will be soldered directly to lugs on the binding posts opposite. Fasten the two binding-post strip brackets under the binding-post strip with the lower angles turned "out."

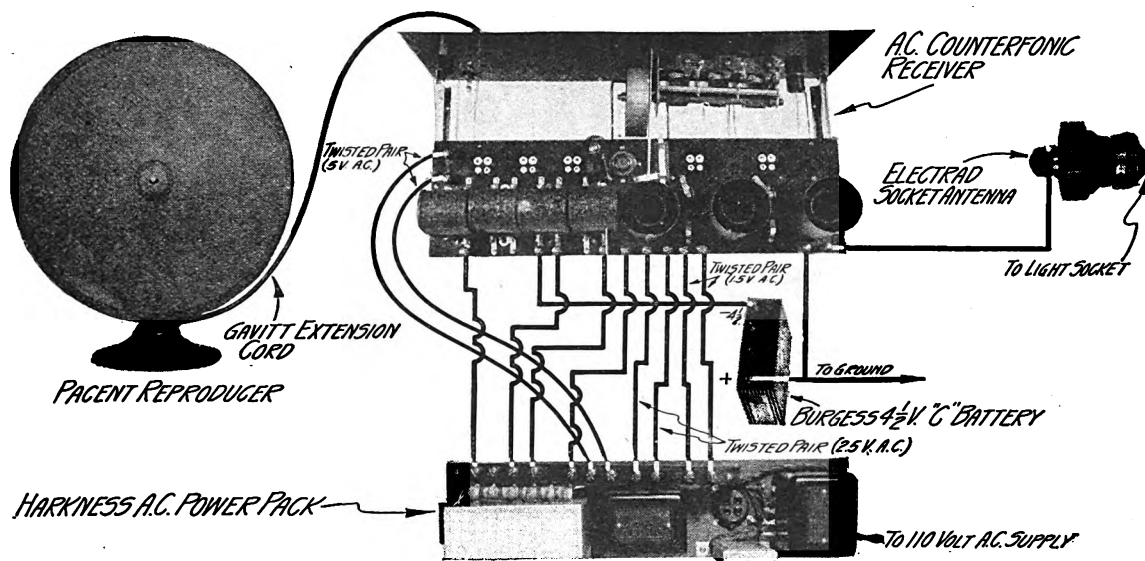
Place all the parts of the power-pack in position on the wooden baseboard, I, and mark the location of the mounting holes for the instruments on the baseboard with a pencil or an awl. Note that the terminals of all the instruments are faced in the direction shown in Figure 6.

Remove all parts from the base and



THE SCHEMATIC DIAGRAM OF THE AC POWER-PACK

FIGURE 4: The wiring of the power-pack to be used in conjunction with the AC Counterfonic, to make the set socket operated, is so simple that a separate picture wiring diagram is not necessary. By reference to this circuit diagram, and the top view of the unit in Figure 6, the wiring may be easily done.



THE HOOK-UP FOR THE AC-IZED COUNTERFONIC

FIGURE 5: Except for the small "C" battery, the current drain upon which is so slight that it is semi-permanent in life, the Counterfonic hook-up shown above is completely batteryless. In addition, the two units are remarkably compact in construction and take up much less space than is required by many socket-operated hook-ups.

drill a small hole for starting each of the round-headed mounting screws.

First mount the Eby sockets, G, with the filament terminals towards the rear end of the baseboard. Next, mount the S-M power transformer, A, with the high-voltage terminals towards the Eby socket. Then fasten the Aerovox buffer condenser, C, in place with the leads turned "away" from transformer A.

Mount the S-M uni-choke, B, with the terminals towards the binding-post strip. Also fasten the Aerovox filter-condenser block, D, in place with the terminals turned in the same direction.

Next fasten down the Aerovox bypass condenser, E, at the end of the large condenser block.

Using two screws through the small angle brackets, fix the binding-post strip, J, in its position two inches above the base.

How to Wire the AC Power-Pack

Wire the instruments exactly as shown in the circuit wiring diagram in Figure 4. Use a twisted pair of wires for connecting each of the 1½, 2½ and 5-volt AC windings to the binding posts.

Support the Aerovox resistor, F, on the binding-post strip by soldering its terminals to lugs on the corresponding binding posts of the binding-post strip.

Follow the directions carefully and check with the picture wiring diagram. This completes the power-pack and it may then be attached to the receiver to furnish complete "A" and "B" power.

How to Install the AC Receiver and the Power-Pack

Place the receiver in a Corbett cabinet and fasten it in place with the

wooden bar along the top edge of the panel.

Place the AC power-pack and the small "C" battery inside the table on which the cabinet stands.

Connect the corresponding terminals of the set to the power-pack with cables run out through the back of the cabinet and down through the holes at the rear of the table. See the composite diagram, Figure 5, for all connections.

Now connect the antenna binding post of the receiver to an Electrad socket antenna and the ground binding post to a water pipe ground. Plug a Pacent cone reproducer in the jack on the front of the receiver.

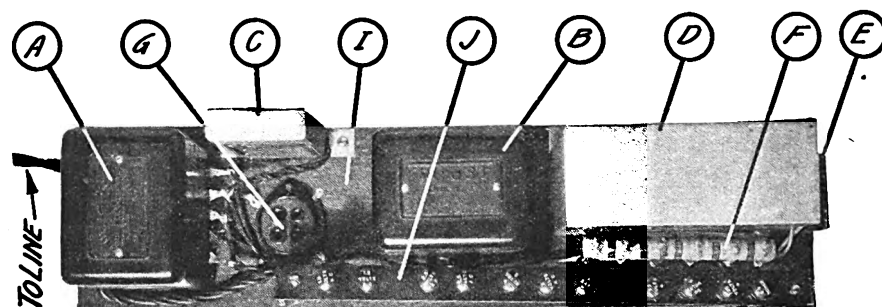
Insert a Raytheon BH rectifier valve in the socket of the power-pack, and four CX-326 type valves in the first, second, fourth and fifth sockets of the receiver. Place a C-327 type valve in the third socket of the receiver and a CX-371-a type valve in the sixth socket of the receiver.

Insert the plug on the AC lead from the power transformer of the power-pack into a 110-volt, AC lighting socket, and the receiver is ready for operation as soon as the detector valve heats up to the proper temperature.

It may be necessary to adjust the arm of the Carter resistor, M2, slightly to reduce the AC hum to a minimum.

The AC receiver is tuned in the same manner as the DC model and the reader is referred to the article in the January, 1928, issue of POPULAR RADIO for further details. It will be found to give better reproduction and quite improved general results because of the superior characteristics of the AC valves which are employed.

The real point of the change, however, is the complete AC operation of the receiver and an absence of worry over battery up-keep. The complete job is an economical receiver from every point of view and one well worth the time and money spent on it.



THE TOP VIEW OF THE POWER UNIT

FIGURE 6: The power unit is built on a long, narrow panel so that it may be placed behind the receiver in the same cabinet. All of the wiring of this unit is done above the baseboard. It is indicated clearly in the schematic wiring diagram in Figure 4.

POPULAR RADIO WORK SHEET

THE PR SHORT-WAVE CONVERTER

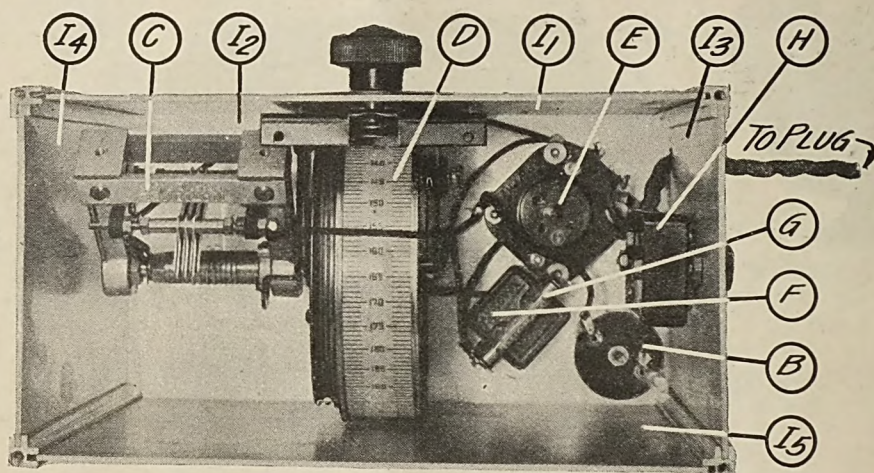


FIGURE 1: THE LAYOUT OF THE PARTS.

LIST OF PARTS FOR BUILDING THIS UNIT

COST OF PARTS: *Not over \$30*

- | | |
|--|---|
| A—Aero coil set, type LWT-125; | clips for grid-leak mounting, .0001 mfd., type No. 1475; |
| B—Aero choke, type No. 60; | G—Lynch resistor, 8 megohms; |
| C—National "Equitone" variable condenser, .00015 mfd.; | H—Samson neutralizing condenser, type No. 61; |
| D—National velvet vernier drum dial, type F; | I—Standard aluminum box shield, 5 by 9 by 6 inches high, made by the Aluminum Company of America; |
| E—Benjamin Cle-ra-tone socket, No. 9040; | Wire, screws, nuts, etc. |
| F—Aerovox moulded condenser, with | |

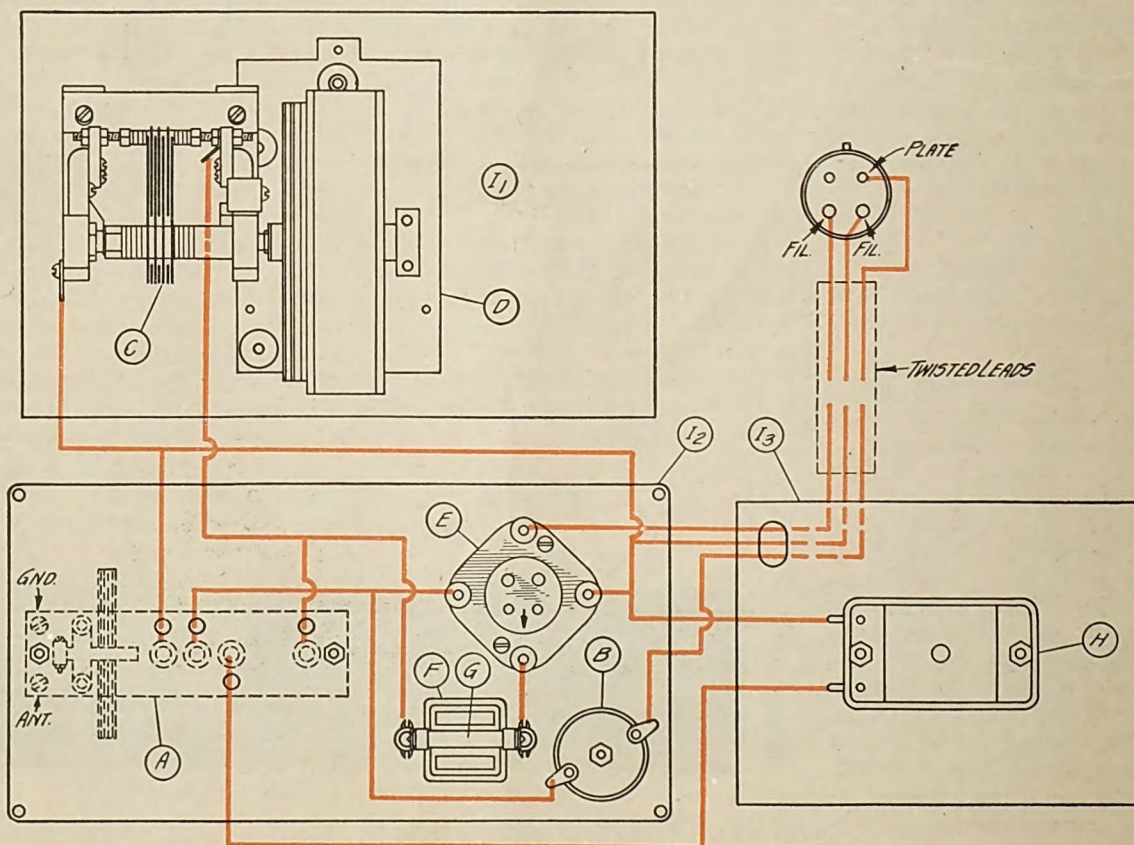


FIGURE 2: THE PICTURE WIRING DIAGRAM.

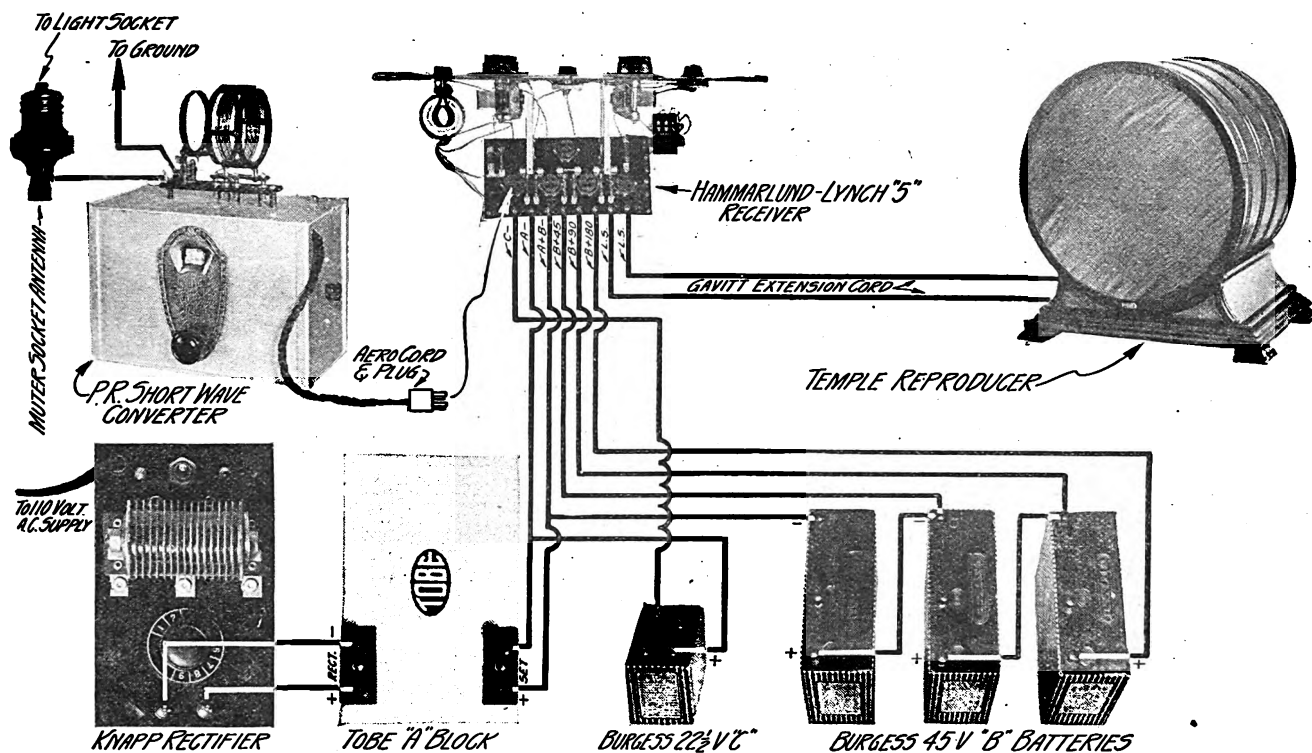


FIGURE 3: The Hammarlund-Lynch "5" is shown here as an example of broadcast receiver with which the PR converter may be used. The converter gets its operating voltages from the same units which supply the broadcast receiver.

Use the PR Short-Wave Converter for Television Wavelengths

By CARL DORF

THE magic short wave and its fascinating possibilities for reception over great distances is bringing many new enthusiasts into this field of radio reception. In addition, with the prospects of regular broadcasting of television becoming more certain every day, the new unit will serve to make these broadcasts, which are transmitted on short waves, available to the experimenter in this fascinating new field.

The POPULAR RADIO Laboratory has been working on this problem strenuously for the past six months and has evolved a converter unit that, it is believed, must successfully solve the problem of short-wave reception with present-day receiving sets.

The new unit is shown on the cover of the magazine and has been designated the PR short-wave converter. It needs no batteries other than those used with the set and no connections other than an antenna and ground and the insertion of a plug into the detector socket of the receiver in use.

The new unit is built entirely en-

Here is POPULAR RADIO'S contribution to the interest in short-wave reception—an easily built, easily installed and inexpensive converter that may be plugged into any receiver for the reception of short waves. Every fan should be anxious to open up this new field where the future of radio and television is now being made.

closed in a standard aluminum box shield, except for the tuning coil, which is mounted on top and which is of the plug-in type for changing wavelengths. It will receive, with the regular set of plug-in coils, on wavelengths continuously from 15 meters up to 130 meters, and can be made for regular broadcast reception by the addition of a standard

wave coil, which also plugs into the same sockets.

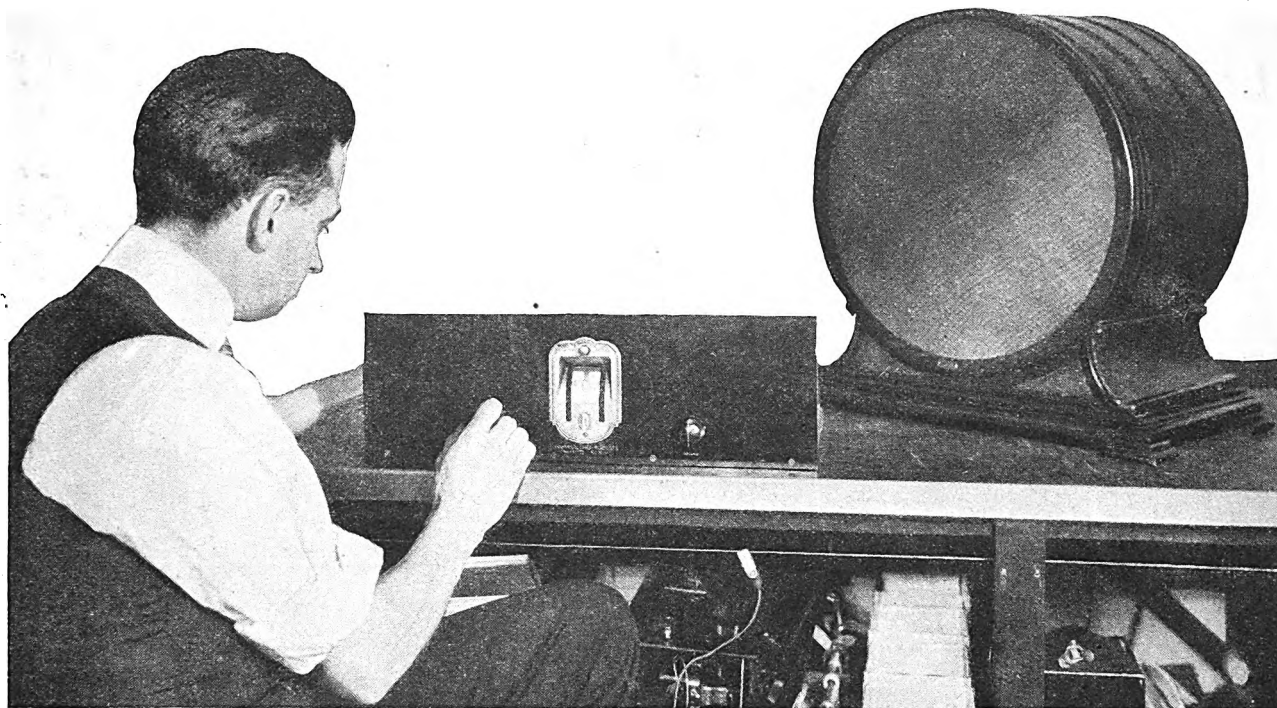
As will be seen from Figures 1 and 2, all of the tuning is done with a single knob located on the front of the converter, to which is attached a drum dial of a new type that insures velvety operation at all frequencies. Regeneration is controlled by a small knob on the right side of the unit and hand capacity has been entirely eliminated. This is an important consideration for short-wave work.

The circuits used in the new converter contain no tricks or eccentricities, but employ a modified form of short-wave circuit that has been thoroughly tested by pioneers in short-wave work.

How to Construct the Converter

In constructing the short-wave converter, the first job will be to drill the necessary holes in the aluminum box shield, I, for mounting the instruments. It will probably be best to start by preparing the front panel, I1,

(Continued on page 342)



HOOK YOUR HI-Q *to the* SOCKET

The popularity of the Hi-Q "Six" has been so great that its designers have devised a socket operated model of the receiver for those fans who wish to combine the good features of the Hi-Q with the convenience of batteryless operation. With the data given in this article the older model may be easily converted, or a new AC receiver built.

By LESLIE BILES

SET BUILDERS who have built the Hammarlund-Roberts Hi-Q "Six" have requested information on a Hi-Q Six receiver that would be totally light-socket operated. They have also asked for the necessary information for converting some of the DC-operated sets, they have already built, for light-socket operation. The purpose of this article is to give the necessary details for accomplishing the complete elimination of batteries from the old sets, and the operation of the receiver from the AC lighting lines.

After a careful consideration of the subject, and numerous tests and experiments, the Hammarlund engineers decided to employ the new AC heater type valves throughout, except in the case of the last amplifier stage, in which a 371 type power valve is recommended.

An improved output filter has also been added to the receiver to handle more effectively the greater volume that is obtained.

How to Make the Mechanical Changes

In building up a new Hi-Q Six re-

ceiver of the AC type it would be best to refer to the article published in the November, 1927, issue of POPULAR RADIO. This article deals with the general assembly details and the set builder is recommended to follow it with the following exceptions:

The new AC valves require a new type of socket capable of receiving five prongs instead of four. These are mentioned in the new list of parts and their positions are designated with letters that correspond with those in Figure 3 and the picture wiring diagram in Figure 4.

Of course, with this type of valve, the filament resistors, R9, R10 and R11, will be eliminated, as well as the three amperites, P1, P2 and P3. A bypass condenser, M1, has been added, shunted across a fixed resistor, S, for the "C" bias necessary on the amplifier valves. These two instruments are fastened underneath the chassis, R2, and they are shown in Figure 2.

Another addition is the 30-henry choke coil, K, and the Parvoltage condenser, P, which is added to the last

stage to act as an output filter. A Clarostat volume control has also been substituted for the Imp battery switch. The original Imp rheostat on the right-hand of the drum dial may be left on the panel, but it is not used in the new model.

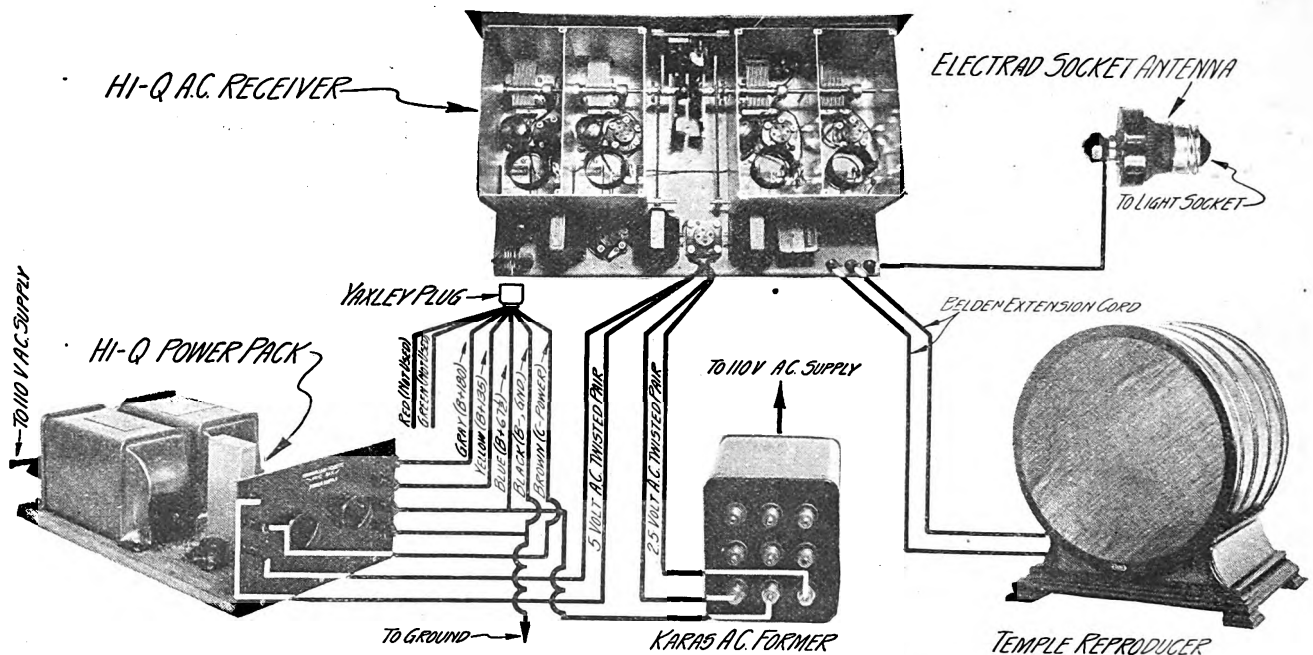
Of course, if a new panel is being made the holes for this latter instrument should not be drilled.

This takes care of the mechanical changes and when the work has progressed to this point the wiring may be started.

The Wiring Changes

In Figure 4, which is the new picture wiring diagram, all of the wiring details for the new receiver are given, with the wires that are to be run on top of the metal chassis shown in the heavy red lines. The dotted red lines indicate where the new wiring is to be run underneath the chassis. All of the instruments and parts are outlined in black lines; the dotted black lines indicate those parts that are to be mounted underneath the metal chassis.

By referring back to the picture



NO BATTERIES IN THIS OPERATING HOOK-UP

FIGURE 1: With the Hi-Q power-pack supplying the "B" voltages, and the Karas AC-Former delivering the current for the AC valves, the Hi-Q becomes a completely socket-operated receiver system.

wiring diagram of the DC receiver, in the November, 1927, issue, the changes that are necessary will be immediately evident. It is recommended that the AC model should be wired up with a rubber-covered insulated wire, such as the Gavitt hook-up wire. Follow the instructions given in the picture wiring diagram and the job will be easy. After the wiring has been accomplished it should be checked for possible errors.

How to Install the Receiver

When the conversion has been finally completed the completed receiver may

be installed in its Corbett cabinet and connected up with the official Hi-Q power supply, which will furnish all of the "B" voltages necessary.

The vacuum valves recommended are the Ceco 27 type AC valves; these should be installed in all of the sockets except the last one, N6, in which a Ceco type F power valve should be inserted.

The photo-diagram in Figure 1 shows all of the connections to be made between the Karas filament-heating transformer, the Hi-Q power supply and the receiver. It also shows the con-

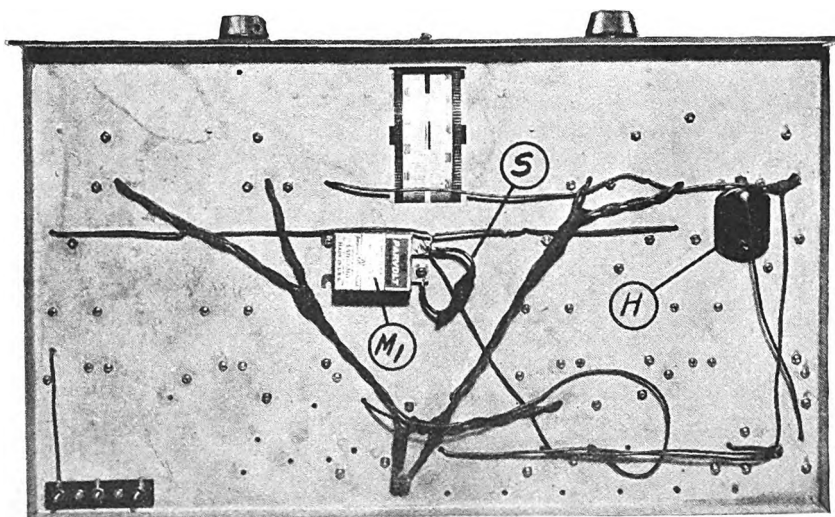
nection to the light-socket antenna and the exponential reproducer. Follow out these connections exactly and when completed the receiver is ready for operation.

When you turn "on" the receiver the 110-volt cord and plug from the Hi-Q power-pack should also be connected to the input of the Karas filament-heating transformer and inserted in a socket of the 110-volt, AC lighting line. The socket switch should be turned "on" and the vacuum valves in the set should immediately begin to glow. A period of 15 to 30 seconds will then elapse before the receiver is in operating condition.

The tuning will then be carried on in the same manner as with the DC-operated set, and the volume control will be accomplished through the new variable resistor, J.

For further details of tuning and operation the reader is referred to the original article on the Hi-Q "Six" receiver. As stated before, the use of the AC valves in the receiver greatly improves its operation and makes a suitable job for the custom-built trade, and presents the custom set builder with a real receiver that he may be proud to sell to any client, knowing that he has something to offer that will compare favorably with any AC-operated receiver now on the market as well as include some features that are obtainable only in a custom-built model.

Once installed, the set should function indefinitely without attention.



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 2: The by-pass condenser, M1, is used in the AC model of the receiver, shunted across the fixed resistance, S, to provide "C" bias for the amplifier valves.

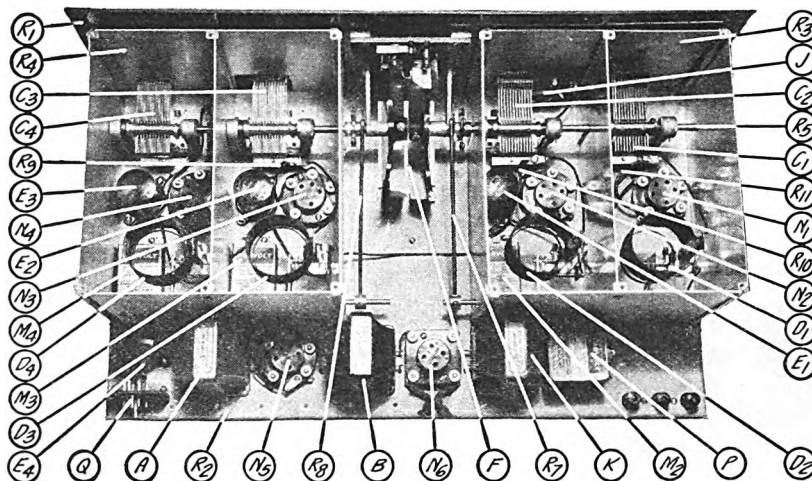
POPULAR RADIO WORK SHEET

THE AC HI-Q "SIX"

LIST OF PARTS FOR BUILDING THIS RECEIVER

COST OF PARTS—Not over \$104

- A—Samson symphonic transformer;
 B—Samson 3-1 transformer, type HW-A-3;
 C1 to C4—Hammarlund mid-line variable condensers, .0005 mfd.;
 D1 to D4—Hammarlund auto-couple coils, HQ-64;
 E1 to E4—Hammarlund chokes, type RFC-85;
 F—Hammarlund illuminated double drum dial;
 G—Sangamo mica fixed condenser, .00025 mfd.;
 H—Sangamo mica fixed condenser, .001 mfd.;
 I—Sangamo grid-leak clips;
 J—Clarostat volume control;
 K—Samson 30-henry choke;
 L—Durham metallized resistor, 2 meg-ohms;
 M1 to M4—Acme Parvolt by-pass condensers, .5 mfd., Series A;
 N1 to N5—Benjamin 5-prong sockets;
 N6—Benjamin vibrationless socket, No. 9040;
 O1, O2 and O3—Eby engraved binding posts, marked *Speaker plus*, *Speaker minus* and *Antenna*, respectively;
 P—Acme Parvolt filter condenser, 2 mfd., Series A;

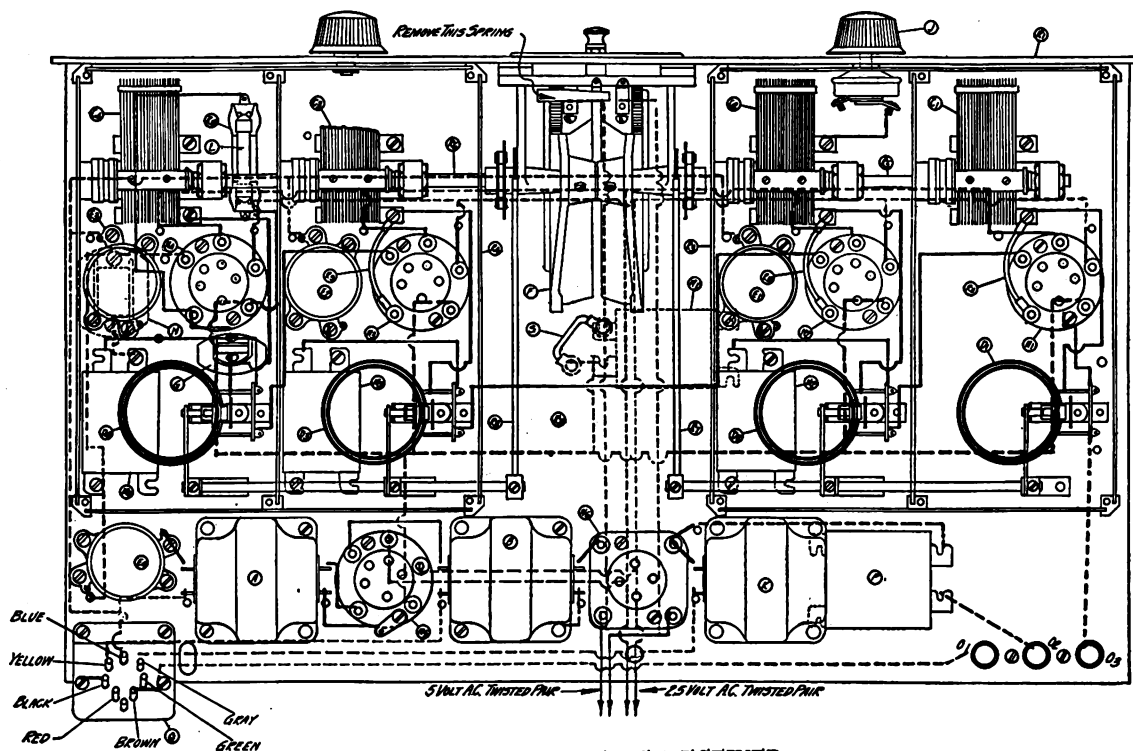


THE RECEIVER VIEWED FROM ABOVE

FIGURE 3: The chief changes in the layout of instruments are the new sockets for the 5-prong valves that are used in all but the final stage of low-frequency amplification.

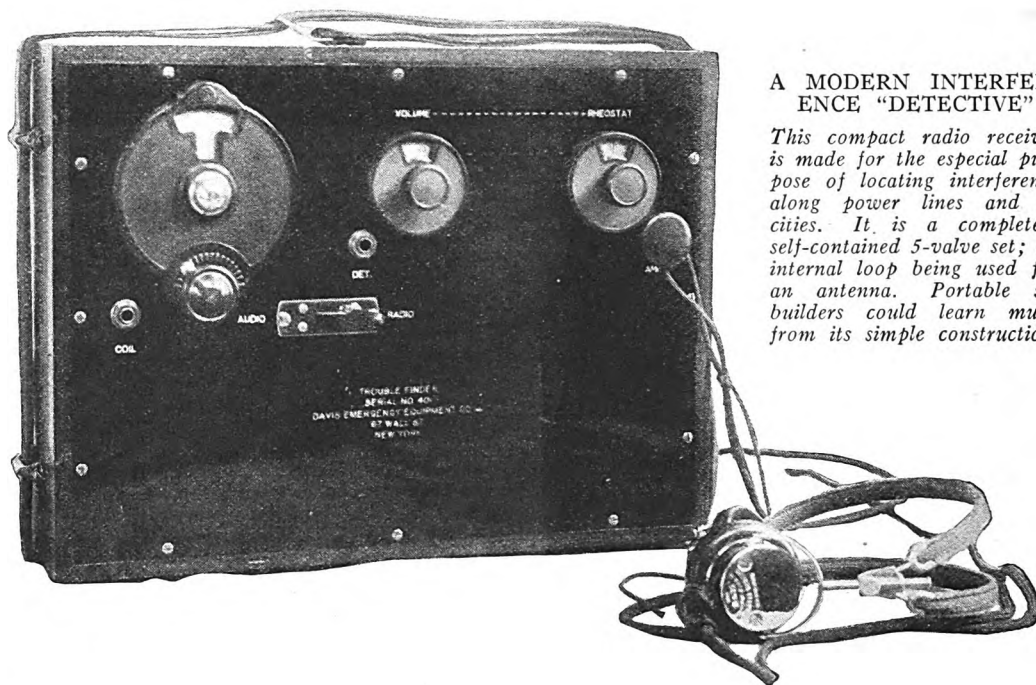
- Q—Yaxley cable connector plug, No. 660;
 R—Hi-Q "Six" foundation unit; containing:
 R1—Drilled and engraved Micarta panel, 7 by 21 by $\frac{1}{8}$ inch;
 R2—Drilled metal chassis;
 R3 and R4—Two-stage aluminum box shields;
 R5 and R6—Brass extension shafts for variable condensers;

- R7 and R8—Cam-operating assemblies;
 R9—Grid suppressor (black);
 R10 and R11—Grid suppressors (red);
 R12—Bakelite grid-leak mounting block;
 R13—Bakelite binding-post strip;
 S—Electrad fixed grid resistance, 200 ohms;
 Wire, screws, solder, etc.



HOW TO WIRE THE AC RECEIVER

FIGURE 4: The wires that are run above the sub-panel are indicated in solid red lines, and those beneath the sub-panel in dotted red lines. The instruments are outlined in black. Dotted black lines indicate instruments mounted under the sub-panel.



A MODERN INTERFERENCE "DETECTIVE"

This compact radio receiver is made for the especial purpose of locating interference along power lines and in cities. It is a completely self-contained 5-valve set; an internal loop being used for an antenna. Portable set builders could learn much from its simple construction.

Running Down the Radio Criminal— Interference

By CHARLES S. ENDERS

LIKE all other departments of radio research, the methods used in locating interference have, within the past five years, and especially within the past two years, been greatly improved and reduced to an almost exact science. Improvements have been brought about not only in the perfection of apparatus suitable for this work, but in the methods employed in operating interference finders for maximum efficiency. There was a time when the location of interference was a matter of haphazard guesswork, involving a great deal of time, effort and money. Today vagrant sounds barely become audible before the "radio detective" corps has them traced down to their source.

This article has been prepared principally for those interested in the most modern methods of interference finding, and professional service men as well as power station operators will find in it many valuable suggestions that have come about through actual experiences in locating interference with an improved interference finder operated from the seat of a sedan. Naturally a car is a great asset in locating interference, since it provides for rapid transportation and relieves the operator of the burden of carrying the apparatus.

Man-made interference is going the way of earlier radio bugbears under the new scientific methods of interference finding practised by large power companies. In this article the broadcast listener will find how this balky problem is being solved, and the professional man will get valuable pointers on trailing the power line hum to its lair.

The make of car is not important, although a six-cylinder car is preferable to a four. A car with good springs and easy riding qualities is desirable, both for the comfort of the operator, and the quiet operation of the set. It also is quieter mechanically. Since the operator will have to be out in all kinds of weather a closed car is of advantage; a closed car also excludes street traffic noises. Where possible, the upper portion of the car should not be of metal. Where an all metal body type of car is

used, it will probably be necessary to make provision for an external loop that can be fastened outside.

Careful attention should be given to eliminate interference caused by the electrical apparatus of the car itself. Some methods used for this purpose are as follows. The generator should receive periodic inspection. The commutator should be kept clean and the brushes properly adjusted. This helps to keep it in perfect condition at all times. If sparking occurs a condenser connected from the positive brush to the chassis will be of help. The distributor also should receive careful attention, care being taken that the contacts are kept bright and properly adjusted. All wiring, with the exception of the high tension leads, should be of the armored type. A shield may be made of lead or copper to fit over the motor block, enclosing the distributor, spark plugs and ignition wiring. This should be made so that it is readily removable, as access to the parts enclosed is often necessary. The shield must be perforated or be made with screening so that air circulation is possible. A condenser may be connected from one side of the primary of the ignition coil to the car frame, either at the ammeter

or directly at the coil. A choke may also be inserted in the primary lead. This should be of the same type as the one described elsewhere in this article.

One or more of these methods will serve to eliminate most of the interference from the car. Slight interference will always be present, due to the ignition system. This is not objectionable, as other forms of interference can be heard through it, and at the same time it serves as an indication that the set is in operating condition.

Radio Equipment Used in Trouble Finding

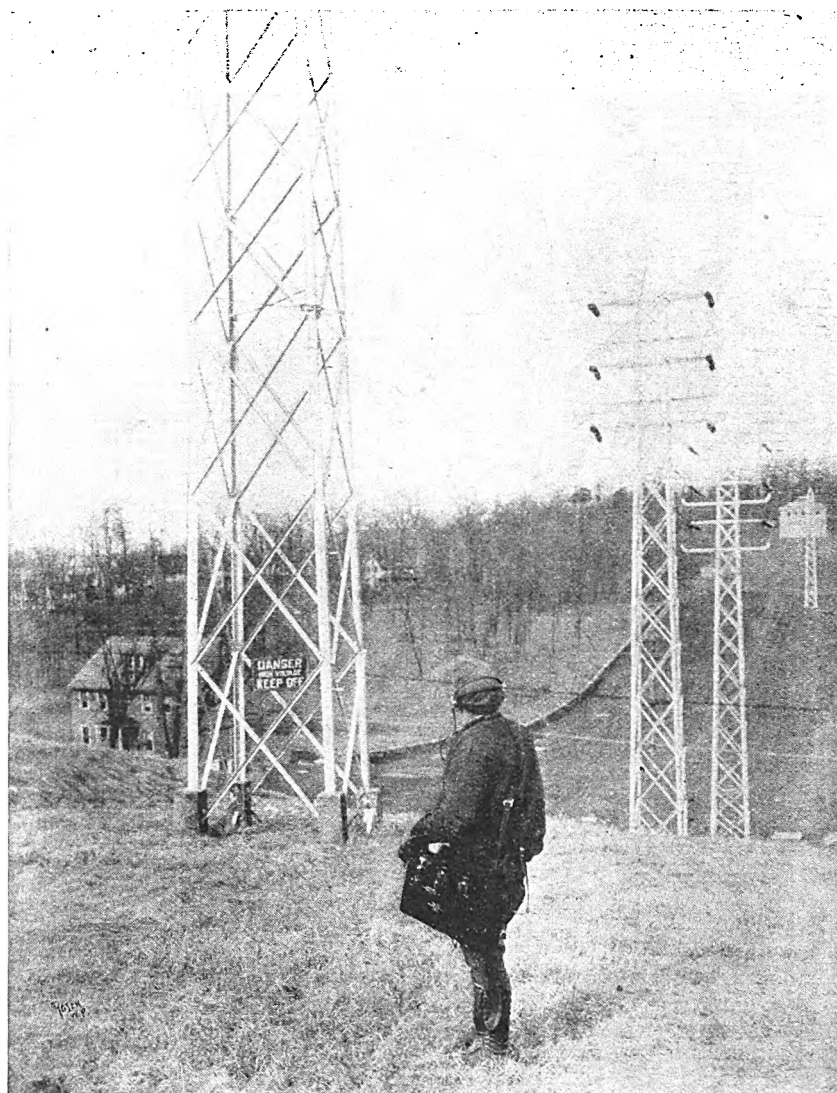
The sets for interference finding used are of many types. Some of them are made by the plant "radio bug." Other companies use sets manufactured for interference work. The type of these sets or "Trouble Finders," as they are called, manufactured by the Davis Emergency Equipment Company of New York, is shown in the accompanying illustrations. This set has been designed after several years of experimenting and as the result of the experience in the trouble hunting field by hundreds of power companies. It is a five-valve set, consisting of two stages of high-frequency amplification, a detector and two stages of low-frequency amplification. Provision is made for the plugging in of exploring coils or external loops by means of a jack which automatically disconnects the internal loop. The high-frequency stages and detector may be used without the low-frequency stages by means of a jack provided for this purpose. The volume and valve controls are equipped with calibrated dials to facilitate volume comparisons.

A switching arrangement is provided which cuts out the high-frequency stages and permits the use of the low-frequency stages alone. This has proved to be of great use in locating cases of trouble which are being radiated along an entire high tension or distribution line with equal intensity at all points. Cases of interference due to street lighting circuits which have been troublesome to locate in the past are also comparatively easy to locate with this set.

Ear phones of sensitive type are used in preference to a loudspeaker in conjunction with this trouble finder, as they help to shut out extraneous noises and enable the operator to hear weak signals which would hardly be audible on a speaker.

A loop receiver is universally used, as it is more compact and does not require the erection of an antenna. In most cases, the loop is mounted in a horizontal rather than a vertical plane,

making it non-directional. The directional value of the loop is of very little use, although it has been greatly recommended by many writers in the past. The uselessness of a directional loop is easily understood when we consider that, from the point of view of interference finding in congested areas, we are dealing with signals that come from antenna systems miles in length that may completely surround the interference finder. It is obvious, of course, that the directional value in such cases is of no use, since the loop will always "throw back" to the nearest power line. The only real place where it may be of value is at corners or places where the lines branch in all directions. By getting directly beneath the lines at this point it may be possible to locate the line carrying the heaviest interference.



WHERE THE FIGHT AGAINST INTERFERENCE IS WAGED

All up-to-date power companies employ a corps of "interference trailers" to police their lines and locate the defects that cause hums and sputters in neighboring receivers. It is such constant vigilance as this picture illustrates that is making the country safe for the broadcast listener and fan.

Methods Used in Trouble Finding

The method more or less universally followed in locating trouble is to trace the source solely by volume indications. A careful survey is made and the central area of the disturbance is located. This is done by cutting down the sensitivity of the set until the interference is barely audible. The line or lines are patrolled in all directions until a point is reached where the volume again approaches maximum. Following this procedure narrows the search down within a small area. For an experienced operator this is comparatively easy. Further search in this area, by using the method outlined above, will in most cases disclose the source of trouble. The reason for cutting down the sensitivity of the set

(Continued on page 332)



An "Air Road" Test With the Marti Electric

By ALBERT G. CRAIG, *Driver*

DURING its seven years of existence, the laboratory staff of POPULAR RADIO has been called upon to test many different types of radio receivers. This testing work has in the past been carried on elaborately, and Staff engineers have been known to devote as much as a week's time in determining the operating characteristics of a single receiver. Scientific measurement of amplification, current consumption, plate and grid biasing voltages and all such things have been determined in an effort to arrive at some definite conclusion as to the general overall efficiency of the receiver under examination.

While this testing work has added a great deal to the Staff's knowledge of the operation of many commercial receivers, it has been found, in the long run, to have been of little assistance to the average reader of POPULAR RADIO or to the lay reader, who seems to be more interested in generalities than in definite scientific facts. This type of radio user may be compared to the man who is interested in an automobile

Just what will a good receiver do? It is this question, rather than the results of complicated laboratory tests, that most fans are interested in. Accordingly, POPULAR RADIO here submits the first of a series of radio "tryouts" on standard receivers, showing exactly what the average set owner may expect from receivers under actual operating conditions.

that will go over the top of a certain hill at 80 miles an hour. This, to him, is a measurement of the efficiency of the mechanism. He cares nothing about the engineering niceties that have made this prodigious power and speed possible. It is in an effort to satisfy the lay readers of POPULAR RADIO that a new method of outlining the operating

characteristics of a receiver has been decided upon. While the engineering staff of POPULAR RADIO will still continue to accumulate its scientific data, the articles devoted to the operation of various receivers tested will be less technical. They will be more in the form of a report of what POPULAR RADIO is pleased to call an "air road test"; being the results obtained by an engineer who simply sits down in front of a receiver and idles the evening away in determining what radio "hills" he can climb and what "speeds" he may obtain. He might do this in the same spirit that an automobile engineer would jump into a snappy roadster and take it over the country roads to satisfy himself that it was either a good or a poor car.

The first radio set to be described under this new editorial policy is the Marti All-Electric receiver. The engineering staff of POPULAR RADIO has expressed a special interest in this receiver, inasmuch as it was one of the first all-electric instruments to make its appearance on the market. As a mat-

(Continued on page 344)

The Long and the Short of Aerials

No receiver is better than the antenna which feeds it. Here are some very practical data in regard to the correct method of erecting antennas and running lead-in wires that every set owner and every professional man should know. A properly constructed antenna, such as is described here, is like an extra stage of amplification.

By ROBERT W. TAIT



THE strange crisscrosses of wires that may be seen on the roofs of many apartments in large cities cause one to wonder why reception results are as good as they are. The "weeping willow" effects of sagging antennas that touch one another at points, or continuously, are the cause of countless radio griefs that many fans are at a loss to explain. Quite frequently good sets are blamed for poor results, and tinkered with and overhauled continuously, when a little care in erecting the antenna would have saved all the trouble in the beginning.

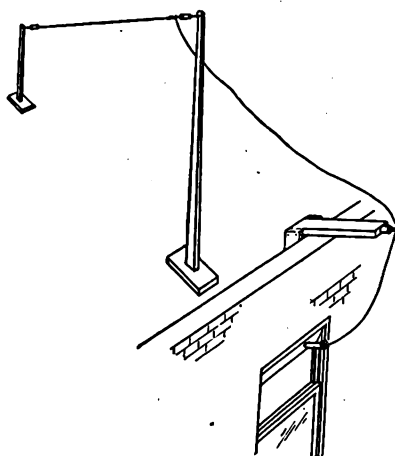
In the past two years various antenna kits have been placed on the market, containing the necessary parts for the erection of antennas. The items which should be included in such kits, for the erection of the ordinary single-wire antenna, are as follows:

- 100 feet of antenna wire, either stranded, plain, or enamel covered;
- 50 feet of lead-in wire and 25 feet of ground wire;
- 3 insulators of glass, porcelain or bakelite;
- 3 wall insulators (the best type is the eyelet with a porcelain insulator in the middle of the eye);
- 1 lead-in insulator;
- 1 lightning arrestor;
- 50 feet of guy wire (iron);
- Large nails, tacks, etc.;
- 2 poles, pipes, or 2-by-4 studs, 10 feet long (these are usually purchased locally).

The erection of an ordinary antenna requires only a few simple tools: a saw,

a hammer, a screw driver, drill and bit, and a pair of wire-cutting pliers. In addition, soldering material and a roll of electricians' tape will make for a neater and more efficient job.

It is well to consider, in the beginning, that an antenna is simply a collector of the energy necessary to operate the radio receiver in a satisfactory manner. Therefore, it is of the utmost importance that the antenna collect as much of this energy as possible, and then, having collected it, conserve it and deliver it to the radio set. Radio energy induced in an antenna continually seeks the shortest path to ground;



A MODEL LEAD-IN

It is important that the lead-in wire be kept away from the face of wall down which it runs. In some cases a home-made bracket such as is shown here will be needed to accomplish this.

hence, it is necessary that due precautions be taken to prevent any leakage or losses that will impair or lessen the reception.

Having made sure that all the necessary material is on hand for the proper erection of an antenna, this material should be taken to the roof, with the exception of the lightning arrestor, the lead-in insulator, and the tacks, which will be used when we have finished our work on the roof.

With about two feet of antenna wire, fasten one of the insulators to the pole, with not less than two turns of this wire, to prevent it slipping down at some future date. About two feet lower than the antenna support which you just made, you may now wrap two turns of the iron wire around the pole, making sure that you cut this wire of sufficient length to reach some suitable support. These supporting wires should extend in a direction opposite that to which the antenna will extend. In some instances three guy wires are necessary. They are for the purpose of assuring the necessary back support for the antenna pole. One end of your antenna wire may now be connected to the free end of the insulator which is already fastened to the pole. Now unwind no more than about twelve feet of the antenna coil, for where a stranded wire is used there is a strong tendency on the part of the wire to become badly snarled unless kept under control.

(Continued on page 330)



In the Professional Set Builder's Shop

Practical pointers and kinks to increase the efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, aided by a well-equipped Laboratory, will find it and present the details here to our readers in a practical and concise manner.

Systematic Trouble Shooting With the POPULAR RADIO Kit

LAST month's issue contained a list of tools and accessories for the professional set builder. The object of this list was to provide an essential kit which would accomplish most of the repairs which the radio doctor would encounter. This article and those to follow, from month to month, will tell you how to use this testing equipment to the best advantage.

It is impossible in this short article to cover the entire ground of radio "trouble shooting," but it is the wish of the writer to instill in the mind of the professional set builders the necessity of a systematic quick method of locating troubles.

The moment you start in on the job test the "A" batteries, "B" batteries, "C" batteries, or their substitutes, and the reproducer. Apply your voltmeter to the "B" batteries, and in the event that they are below 36 volts for each 45-volt block, advise new ones. Test "C" batteries for voltage also and note their condition. Test each cell of the "A" battery, and if one of the cells seems to read below the others to a marked degree advise a thorough cleaning of the battery together with a cell replacement for the defective one.

With "B" eliminators, the procedure is slightly different. It is preferable to test the "B" eliminators for voltages with the set turned on, using a high-resistance voltmeter and the leads with clips. Check the voltage output under

load. If the voltage readings are abnormally low it may indicate a short in one of the circuits of the eliminator. With the ordinary type of eliminator, a 0-50 milliammeter may be placed in series with each plus lead successively without endangering the instrument. A detector tap using but one detector valve should show a reading of $\frac{1}{2}$ to one milliamper. The tap supplying the high-frequency valves should show about 3 mils per valve. Frequently the first stage of low frequency receives its plate supply from this same source. Therefore it follows that with two stages of high-frequency amplification and the first stage of low-frequency on one tap, the current should approximate 9 mils on this tap. With "C" bias on the high-frequency valves, and the low frequency it will probably be less. This current also varies with the applied voltage. The higher the voltage the more current or mils will be used.

The high voltage tap will vary in current with the type of valve used. Valves of 171 and 210 types draw considerably more than the 201-a type.

In the event that one of these taps draws considerably more than you think it should, it indicates trouble within the set. If it should happen to be the tap supplying the high-frequency valves, remove each of the valves in turn, and also the first low-frequency valve if it is supplied by this same tap. This is to make sure the valves are not at fault and contain no internal "short." Any sudden jump in voltage of 40 to 80

volts when a valve is removed would indicate a defective valve.

Next, remove the trouble-making taps from the set and observe if there is any change in voltage reading. With the tap not in use there should be a slight increase in voltage reading. (This would not apply to the detector taps, since the current drain is too small to make an observable increase in voltage. In any event the detector tap rarely gives trouble because of the low voltage and small current drain.)

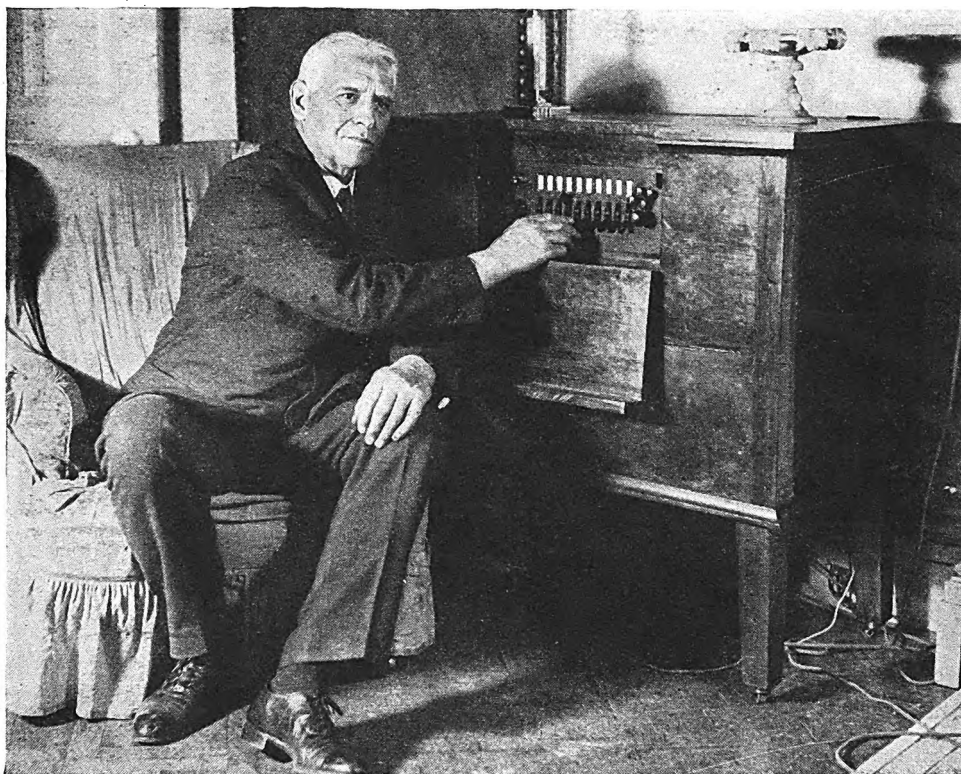
The safety factor for condensers and resistances used for the detector tap is much larger than for the other taps.

If this increase in voltage does not occur, put a variable resistance or load in the circuit. If no current drain is shown by the milliammeter it is certain that the circuit is open or that there is a direct short-circuit in the eliminator. The direct "short" is generally traceable to a by-pass condenser.

The reproducer should be tested with a "C" battery, phones and test clips, all in series. A loud click results when circuit is complete. Reproducer windings are sometimes open-circuited due to overload, or the tinsel cord with which the speaker is equipped may become frayed and open. Therefore, if there is no response in test, try again at the terminals of the reproducer unit. If the unit is open-circuited, it is generally advisable to send it to the manufacturers for repair, for with the facilities they possess, a better job is certain.

ROBERT W. TARR.

(Continued on page 346)



Acme

PRESS THE BUTTON FOR YOUR FAVORITE STATION

Tuning is reduced to the simple operation of pressing a button in this receiver designed by Harry N. Marvin, of Rye, N. Y. Each prominent broadcasting station around New York has a button, and pressure on that button automatically tunes in the station. When other stations are wanted, the ordinary method of tuning in may be brought into use by throwing a switch.

What's New *in* Radio

Conducted by
THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.

A 120-Inch Exponential Horn

Name of instrument: Racon exponential horn.

Description: This new exponential horn, which is scientifically shaped and designed to meet the best standards of acoustical engineering, has a total length of 120 inches. The basic material from which the horn is made is a special fleeced underwear cloth, impregnated with compounds which will give the material the proper acoustical characteristics. The horn contains three convolutions and is responsive to a range of frequency as low as 54 and as high as 7,500. This frequency range will accommodate the best low-frequency amplifiers that are in use today. Due to the extreme hardness of the material with which the cloth is impregnated, the horn has a very substantial solidity and may

be subjected to unusual abuse without danger of damage. The speaker unit is of the balanced armature type and capable of handling heavy overloads without distortion. Each



speaker is made by hand over a special collapsible form, so that the characteristics of each horn are uniform. The horn has an overall width of 18 inches and a height of approximately 19 inches. Each one is provided with a speaker cord of sufficient length.

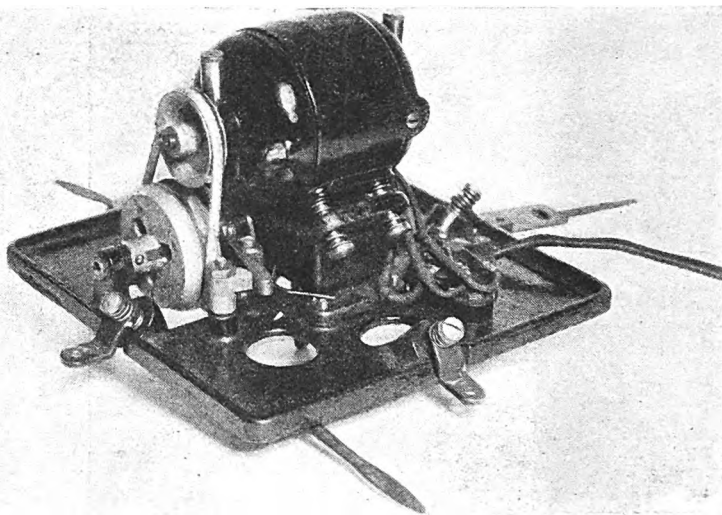
Outstanding features: Rigidity of construction. Wide frequency range. Tonal chamber 120 inches long, confined to a comparatively small space.

Maker: Racon Electric Co.

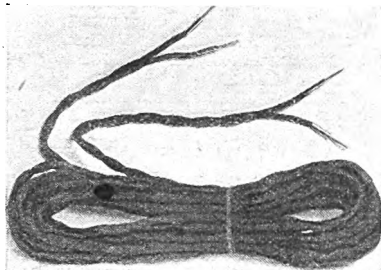
High Power Loudspeaker Cord

Name of instrument: High-power loudspeaker cord.

Description: This rubber-insulated, heavy-duty speaker cord is made to handle the output current and voltage of the more powerful low-frequency amplifiers in use today. Inasmuch as output current on the larger units runs



as high as 50 milliamperes, and the voltage on low notes anywhere between 400 and 1,300 volts, ordinary tinsel cords have been found more or less inadequate for this new service. This cord is impervious to moisture and has been successfully tested on voltages as high as 7,000 without showing signs of a breakdown. Thus it may be laid on the floor without danger of being rendered useless by water from steam radiators, or by rain entering open windows. It is obvious that cords with ordinary coverings are exceptionally susceptible to breakdowns in insulation due to the absorption of even a small amount of water. While this would be more or less inconsequential where such cords are used in connection with low-powered sets, high-powered receivers



with voltages that may easily reach 1,000 would be rendered inoperative through what would almost amount to a direct short-circuit. This new cord is made up of comparatively small stranded wire, twisted so as to minimize hum by induction where the cord is laid parallel to lamp and fixture cords that may be lying on the floor. The cord is provided with tips and supplied in lengths of 30, 50, and 100 feet.

Outstanding features: Extra-heavy insulation. Twisted so as to eliminate AC hum. Absolute freedom from danger of shock.

Maker: Gavitt Manufacturing Co.

An Electric Phonograph Motor

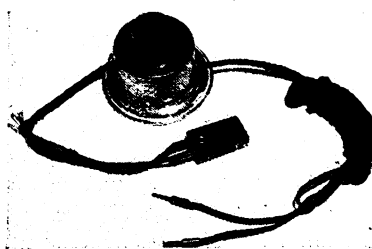
Name of instrument: Johnson-Gordon Phonograph Motor.

Description: To satisfy the demands created by the thousands of radio fans

who are now busy converting their old phonographs into modern electric reproducers, an extremely efficient and quiet electric driving motor has been placed on the market so that converted phonographs may not only have electrified reproduction, but electrified operation as well. The motor, which is a Universal type, is mounted on a spring suspension and connected to the driving disc through the medium of an elastic belt. The elastic belt drives a governor which is mounted on the same shaft with the large wheel. The turn table is driven through the medium of two spirally cut gears. Arrangements are also provided to adjust the speed of the turn table. The motor is mounted on a cast iron plate and also provided with an automatic stop. Each motor is equipped with an adjusting switch so that it can be made to operate on AC current from 25 to 60 cycles, or on DC current.

Outstanding features: Spring suspension. Automatic stopping. Speed adjustment. Quiet operation. Universal application.

Maker: The SAAL Co.



A Table Type Volume Control

Name of instrument: A table type Clar-o-Stat.

Description: The manufacturer of this volume control has given it an ornamental appearance, so that it may be used in conspicuous places without destroying the artistic values of its environment. The volume control is mounted in an antique copper case and provided with an adjustable knob of a color to match. The bottom of the instrument is covered with green felt to prevent its marring polished furniture on which it may be placed.

Turning the knob to the right increases the resistance, while turning it to the left decreases the resistance. Inasmuch as the resistance is variable between extremely wide ranges, the Clar-o-Stat has a multitude of uses. Each unit is provided with two cords terminating in convenient tips. And there is also supplied a connector block, further to facilitate ready inclusion into radio circuits.

Outstanding features: Wide range of resistance. Artistic appearance and good mechanical construction.

Maker: American Mechanical Laboratories.



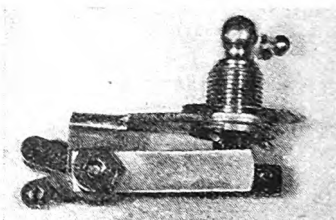
A Midget Volume Control

Name of instrument: Clar-o-Stat volume control.

Description: This volume control, while extremely small in size, although rugged in construction, is able to provide an unusual range of resistance that may be uniformly varied between approximately zero and 500,000 ohms. The resistance unit is of the compression type, and is encased within a polished nickel container, provided with bakelite insulation and terminals with machine screws. The instrument is made for single-hole panel mounting, and a well-designed bakelite knob is used to vary the resistance.

Outstanding features: Wide variation in range of resistance, with uniform graduation. Unusually good mechanical construction. Single-hole mounting.

Maker: American Mechanical Laboratories.



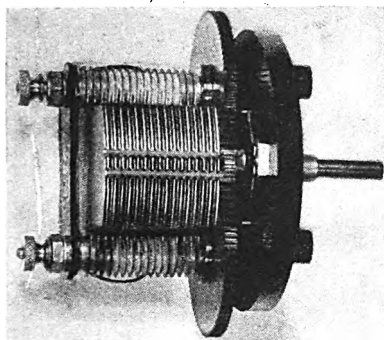
A Convenient Jack Switch

Name of instrument: Short jack switch.

Description: This switch is for single-hole panel mounting, with the toggle lever and marker plate on the front of the panel and the switch blades behind and parallel with the panel. This arrangement saves space, and the design is such as to provide positive contact. Switches of this kind are useful for antenna or "A" battery switching and are made in several different types, including single pole, single throw; single pole, double throw; double pole, single throw, and double pole, double throw.

Outstanding features: Low cost. Reliable contacts. Compact size.

Maker: Carter Radio Co.



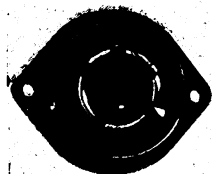
A Condenser With an Insulated Shaft

Name of instrument: Twin rotor variable condenser, type No. 639.

Description: This variable condenser is out of the ordinary in many ways, principally in the fact that neither set of plates is directly driven by the shaft. The two sets of brass plates are identical in appearance and are rectangular in shape. Each set is mounted on a bakelite gear wheel and these two gear wheels are engaged with a smaller brass gear wheel that is mounted directly on the end of the shaft. Thus when the shaft is turned the two sets of plates move and intermesh or separate, as the case may be, thus increasing or decreasing the capacity. The particular type described here has a maximum capacity of .0005 mfd. and the unusually low minimum capacity of .000003 mfd. This type of condenser is suitable for any use to which any variable condenser may be put, and is particularly well suited for use in circuits where neither side of the condenser is at low or ground potential because of the decreased body capacity effect brought around by the insulation of the shaft. A full revolution of the dial is required to vary the capacity from minimum to maximum, so the necessity for a vernier dial is eliminated.

Outstanding features: Insulated shaft provides effective shielding against body capacity. Available in either S. L. F. or S. L. W. types and in capacities from .0001 mfd. to .0005 mfd. May be mounted direct on metal panel, without requiring insulating bushings.

Maker: Remler Division of Gray & Danielson Mfg. Co.



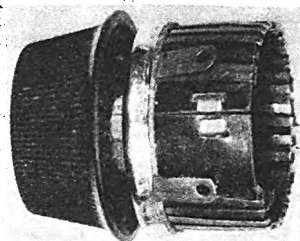
A Valve Socket for Baseboard or Sub-Panel Mounting

Description: This composition valve socket is made in two types, one for 4-prong valves and the other for 5-prong valves, such as the C-327. Either of these sockets may be mounted on a baseboard or on the top or under side of a sub-panel. The bases of the sockets are extended in the form of wings to accommodate two mounting screws. Inasmuch as

the mounting screws are insulated from the contact springs, these sockets may be mounted on metal if so desired. A welcome diversion from standard practice is offered by the fact that the holes which accommodate the prongs of the valve are set down in a guide groove to make insertion of the valve a simple matter, even in the darkened interior of a receiver.

Outstanding features: Small size. Good contacts. Universal mounting. Furnished with guide groove. Direct contact soldering terminals.

Maker: H. H. Eby Mfg. Co.



A Heavy Duty Rheostat for AC Valve Circuits

Name of instrument: Heavy duty rheostat.

Description: The resistance material in this rheostat is in the shape of a flat ribbon which is wound flatwise on a composition strip. This type of winding provides adequate heat dissipating surface, as required in a really heavy-duty rheostat. The frame of this unit is of metal and the slider is especially designed to provide good contact, but at the same time slide easily. The rheostat will dissipate 6 watts and is available in resistances from 1/5 ohm to 50 ohms. It is capable of handling up to five of the 326 type valve filaments and the variety offered in the above range will meet all AC filament requirements.

Outstanding features: Rugged construction. Heavy current handling ability. Inexpensive. Well designed. Equipped with engraved knob and designed for single-hole panel mounting.

Maker: Carter Radio Co.

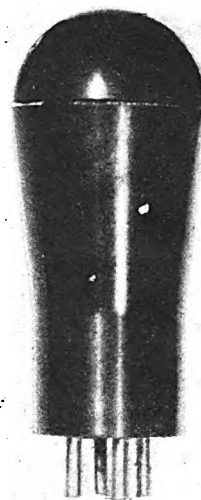
Make Your Receiver Do Stunts With This Unit

Name of instrument: B. M. S. Home Broadcaster.

Description: This home broadcasting outfit consists of a microphone, socket plug, extension cord and extension cord connector. When the microphone is connected to the socket plug and the latter is inserted in the detector socket of a receiver, in place of the detector valve, the low-frequency amplifier of the receiver may be used for the reproduction of the voice of anyone speaking into the microphone. Its use turns any receiver into a public address system on a small scale and offers innumerable possibilities for amusement and utility.

Outstanding features: Requires no alterations in the receiver or amplifier. Employs no extra batteries. Neat in appearance.

Maker: Brooklyn Metal Stamping Co.



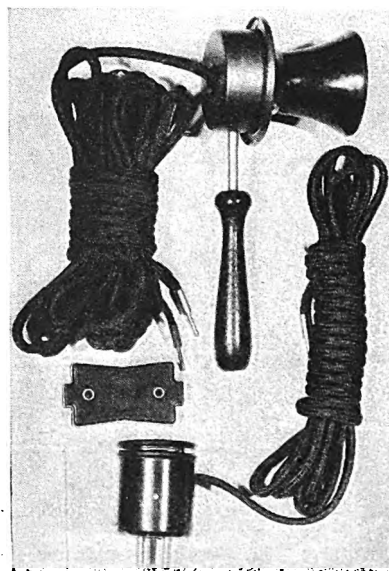
A Crystal Detector for Use in Any Receiver

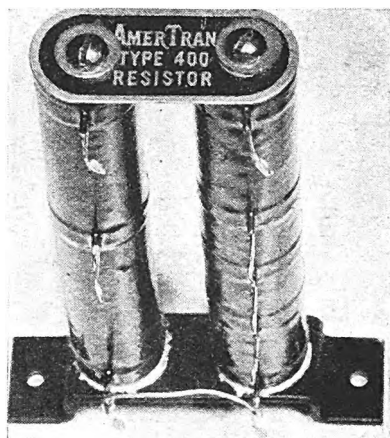
Name of instrument: Tube type carborundum detector unit.

Description: This new type of crystal detector takes the form of a vacuum valve, but it is made with composition walls instead of glass. It has a standard 4-prong UX-type base and fits into a standard valve socket. The detector consists of a carborundum detector and potentiometer which are completely inclosed within the composition bulb. The four prongs at the base of the unit correspond exactly with those of a standard vacuum valve base, and this crystal detector unit may therefore be incorporated in any receiver by simply removing the present vacuum valve detector and replacing it with the new crystal unit.

Outstanding features: The superior tonal qualities of the crystal detector may be taken advantage of in any receiver which was designed for the use of a valve detector. No changes in the wiring of the receiver are necessary in order to substitute the new crystal detector, nor are additional batteries or connections necessary.

Maker: The Carborundum Co.





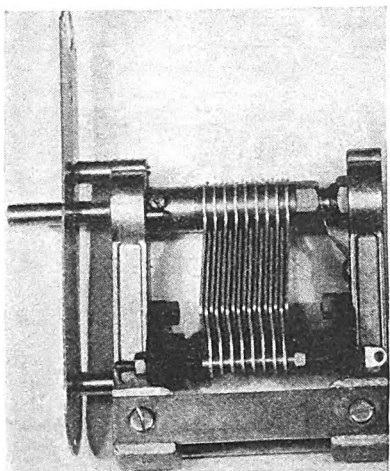
A Tapped Resistance for Voltage Control in Power-Packs

Name of instrument: AmerTran plate voltage tapped potentiometer.

Description: This resistance unit consists of two resistance coils connected in series and with a total "cold" resistance of approximately 41,000 ohms. The coils are mounted side by side in a vertical position, with mounting holes provided in the metal base. When connected as the voltage divider across the output of a high-voltage "B" power-pack, this unit will provide six different output voltages. Inasmuch as only three output voltages are normally required for this work, it is evident that this AmerTran unit will meet all normal requirements. The resistance is of the heavy-duty type and capable of handling the outputs of power-packs rated up to 500 volts. The entire unit, when mounted in a vertical position, occupies a base-board space of only $3\frac{1}{4}$ by $\frac{7}{8}$ inch. The height is $5\frac{1}{4}$ inches.

Outstanding features: Neatly made. Ample safety factor in power dissipation rating. Resistance windings sealed in composition material.

Maker: American Transformer Co.



A Fine Condenser for Simplified Tuning

Name of instrument: "Equitone" adjustable condenser.

Description: This aluminum condenser offers a number of unique and highly

practical features to the set constructor or to the user of a receiver. It is of rigid construction and is carefully designed and assembled. Insulation is good and losses are low. The fabricated metal frame insures permanent characteristics. It is attached to the receiver panel by means of two mounting screws, and the sub-panel of the receiver may be supported by the bottom of the condenser frame, thus eliminating brackets. The frame is drilled and tapped at the bottom for this purpose. The shaft is removable to permit the substitution of a long shaft where it is desired to gang several of the condensers on a single shaft for single control. This condenser provides straight-line frequency tuning throughout the lower half of the scale and straight-line wavelength tuning through the upper half. This design provides a very useful separation of broadcasting stations throughout the dial range.

Outstanding features: Combines SLF and SLW tuning. Serves both as tuning device and support for the receiver sub-panel. May be used either for base or panel mounting. Fine construction and accurate. A very worth-while piece of apparatus.

Maker: National Co.



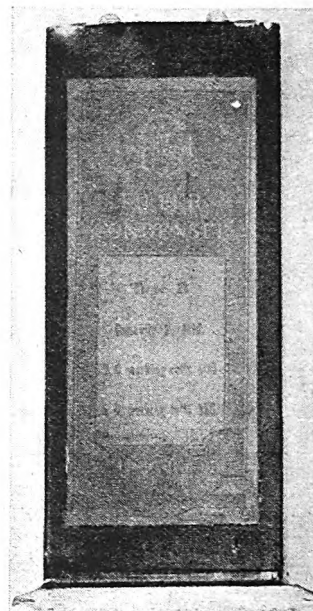
Make Your Set a Short-Wave Receiver With This Unit

Name of instrument: "Submariner" short-wave adapter.

Description: The "Submariner" is a single-valve, short-wave receiver so designed as to permit it to be used with the low-frequency amplifier of any receiver to provide reception of broadcasting and code transmission on wavelengths below 100 meters. It is equipped with a cord and plug to insert in the detector valve socket of any standard receiver, thus making connection to the amplifier of the receiver. No changes in the wiring of the standard receiver are necessary, nor are additional batteries needed for the "Submariner." All connections are automatically made through the insertion of the plug in the detector socket of the receiver. All short-wave tuning is accomplished by means of the dial and knob on the front of the "Submariner." Any standard type of valve may be used in this unit.

Outstanding features: Permits reception of the short-wave broadcasting and amateur code transmission. Low price. Easily installed.

Maker: J-M-P Mfg. Co.



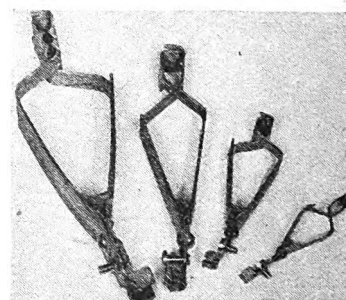
A Good Condenser for High-Voltage Work

Name of instrument: Filter condenser, type B.

Description: This condenser is of the high-voltage type and is especially designed for use in power-packs where the working voltage is less than 600 volts DC. It is convenient in size and equipped with mounting feet. Terminals are in the form of soldering lugs brought out through an insulating plate at the top of the unit.

Outstanding features: Rated at 600 volts, DC. Inexpensive. Easily mounted.

Maker: Polymet Mfg. Corp.



Sure Contact for Storage Battery Terminals

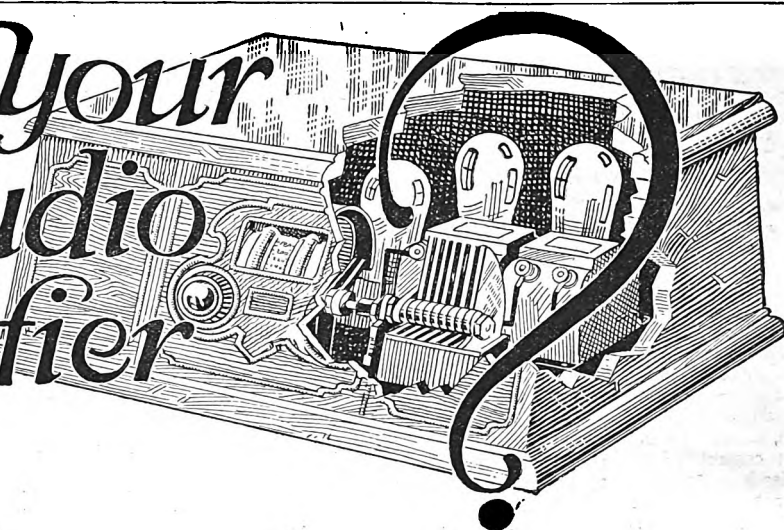
Name of instrument: "Shanco" battery clips.

Description: These spring type battery clips consist of husky steel or iron springs with sharply toothed jaws which will dig into the lead terminals of a storage battery and provide a sure-fire contact. The clips are "dipped" with lead, to protect the spring metal from the corrosive action of the battery acid. They are equipped with screw terminals and saddle washers for attaching the connection wire.

Outstanding features: Strong grip. Protected from corrosion. Made in various sizes up to $5\frac{1}{2}$ inches in overall length.

Maker: Shanklin Mfg. Co.

How's Your Old Audio Amplifier



You Can Make Your Present Receiver a Real Musical Instrument

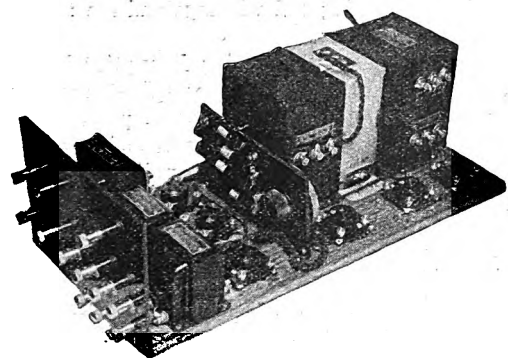
Recent developments in radio have all been centered around improved tonal reproduction—this means advancement in the systems of audio amplification.

No need to discard your present receiver, however, to enjoy the finest radio reproduction possible. A modern Thordarson Power Amplifier, coupled into a good loud-speaker will convert your radio set into a musical instrument beyond reproach.

Thordarson power amplifiers are simple to assemble. With a soldering iron, a pair of pliers, a screw-driver and a small drill you can assemble any unit in an evening in your own home.

The Thordarson label assures you of unquestionable quality and performance; Thordarson transformers are standard equipment on the world's finest receivers and power units.

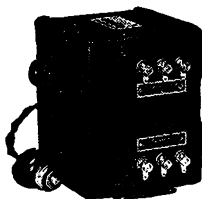
Give your receiver a chance to reproduce real music. Write today for complete constructional booklets sent free on request.



This heavy duty amplifier is a complete audio system employing UX-210 tubes in push-pull, furnishing B-supply to the receiver, and designed to operate the new dynamic speakers. Fully described in March Popular Radio.

POWER SUPPLY TRANSFORMER T-2098

A heavy duty supply transformer that furnishes power for the above amplifier. Furnishes current for two UX-281 rectifiers. Capacity 130 milliamperes, sufficient current for any receiver regardless of drain. Price, \$20.00.



DOUBLE CHOKE UNIT T-2099

Consists of two individual chokes of 30 henries, 130 milliamperes each, in one compound filled case. Price, \$14.00.

R-200 Amplifying Transformer. An audio transformer with an unusually wide tonal range. Extremely faithful in reproduction. Price, \$8.00.

Push-Pull Transformers. Quality reproduction that cannot be obtained with straight audio amplification is made possible by the Thordarson Power Push-Pull transformers. Input transformer T-2408, price \$8.00. Output Choke T-02420, for high impedance speakers, \$8.00. Output transformer for low impedance dynamic speakers, price, \$10.00.

— COMING! —
THE THORDARSON
Z-COUPLER

WATCH FOR ANNOUNCEMENT NEXT MONTH

THORDARSON

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Wurton and Kingsbury Streets — Chicago, Ill. U.S.A.

Adds the Final Touch

TABLE TYPE CLAROSTAT

Reg. U. S.

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THE ideal control for volume and tone of your loud-speaker, from soft, soothing background for conversation, reading, dining, resting, phoning or dozing, to loud, crisp, snappy entertainment for center of interest. And it's always at your finger tips—on the end table, easy-chair arm, dining table, davenport, sick-room table, telephone stand—anywhere for remote control of radio entertainment.

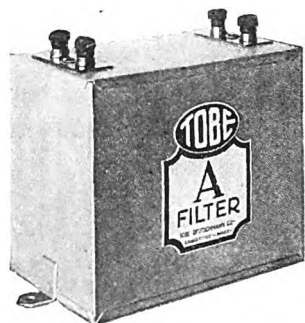
Handsomely finished in statuary bronze and nickel. Felt bottom to protect finest furniture. Bakelite knob. Two cords with tips and connector block for applying to battery or socket-power set, without tools, skill, time or trouble. Learn the new joys of controlled radio! And all for \$2.50!!

Ask your radio dealer to show you the Table Type Clarostat and give you copy of "Radio Etiquette". Or write us direct for interesting data on improving your radio.

American Mechanical Laboratories
Incorporated

Specialists in Variable
Resistors

285-7 N. Sixth St.,
Brooklyn,
N. Y.



A-FILTER

A new and different dry condenser of 3600 Mfd. cased with chokes of proper size, to supply humless A-current to any set when connected to proper type of standard battery charging rectifier. Condenser is also sold separately. Send in coupon today.

Tobe Deutschmann Co.

11 Windsor St., Cambridge, Mass.

Please send me Pamphlet L-4 on your New A Filter & A Condenser and your Set Builders Proposition.

Name.....

Address.....

The Screen Grid Valve Finds a New Job in the QSA-5

(Continued from page 294)

it is found that the voltage changes are so great as to cause the power valve to block. To avoid this tendency and to allow handling of the full signal volume, the second autoformer is used to provide a high impedance for the signal frequency with a low resistance path for the escape of direct current from the grid of the power valve.

A self-contained power unit is placed at the extreme left-hand end of the sub-panel. The only other power supply required is a 6-volt "A" battery. Inclusion of the power apparatus with the amplifier eliminates five external wires as well as a separate housing for this essential part of the equipment. This portion of the apparatus includes a power compact, I, containing a transformer with one secondary winding for the plate supply and another for the power valve filament current. The compact also includes two filter chokes and two buffer condensers for the rectifier valve. The condenser block, J, contains the three filter condensers and two of the by-pass condensers, a third by-pass condenser, S, being separately mounted under the sub-panel.

Each of the three box shields, C1, C2 and C3, contains a complete stage of amplification, including the tuning coils or transformers, the tuning condensers, the coupling chokes and condensers, and the valves themselves.

All of the shields are connected to ground by means of a wire running

underneath the sub-panel. The negative terminal post for the "A" battery is connected with this ground line and the greater part of the negative filament circuit is then completed through the shields by the attachment to them of the filament resistors of the screen grid valves and by a direct connection from the negative terminal of the detector socket. All grid and plate returns are likewise made through the shield metal and through the negative wiring by simply attaching to the shields the tuning coil windings and the tuning condensers.

From the foregoing description it will be seen that the new QSA-5 receiver offers, to the amateur and professional set builder alike, a number of new features in the way of radio broadcast reception device not encountered in any other receiver. Its possibilities in the reception of long distance signals with a short antenna of only a few feet in length make it applicable for local and distance reception in crowded metropolitan areas, and at the same time the quality of reproduction has been preserved in getting the necessary selectivity for this work.

In the next issue complete constructional details of this new receiver will be given. For the benefit of those who wish to buy the parts for the receiver now, so as to have them on hand when the constructional data appears, the complete list is given below.

LIST OF PARTS FOR THE QSA-5 RECEIVER

TO BE FEATURED IN POPULAR RADIO FOR MAY, 1928

A1—Aero antenna coil, type No. 96;
A2 and A3—Aero universal coils, type No. 43, equipped with two special Aero primary coils, type No. 111;
A4—Special home-made plate coil;
B1 to B3—Hammarlund midline variable condensers, .0005 mfd.;
C1 to C3—Hammarlund stage shields;
D—Hammarlund double-drum dial;
E1 and E2—Hammarlund high-frequency chokes, type No. 85;
F—Thordarson low-frequency transformer, type R-200;
G1 and G2—Thordarson autoformers, type R-190;
H—Thordarson speaker coupling transformer, type R-76;
I—Thordarson power compact, type R-171;
J—Aerovox filter condenser block, type TH-862;
K1 and K2—XL Vario-densers, type G-1;
L1 to L6—Benjamin Cle-ra-tone sockets, No. 9040;
M1 to M3—Aerovox wire-wound resistances, 10 ohms, type No. 980;
N1 and N2—Aerovox moulded condensers, .00025 mfd.;
N3—Aerovox moulded condenser, .001 mfd.;
N4—Aerovox moulded condenser, .00025 mfd., with grid-leak mounts;

O—Durham metallized resistor, 1 megohm;
P1 to P3—Control grid connectors;
Q1—Aerovox Pyrohm resistance, with two extra taps, 10,000 ohms, type 994-QSA;
Q2—Aerovox Pyrohm resistance, 2,000 ohms, type No. 992;
R1 and R2—Yaxley Junior rheostats, 10 ohms, type No. 510;
R3—Yaxley Junior rheostat, 3 ohms, type No. 503;
R4—Clarostat volume control;
R5—Centralab heavy-duty potentiometer, 5,000 ohms;
S—Aerovox filter condenser, type 200, .25 mfd.;
T1 to T3—Benjamin brackets, type No. 8629;
U1 to U6—XL push posts with new bakelite top;
V—Carter automatic power switch, type No. 115;
W—Westinghouse Micarta panel, 9 by 30 by 3/16 inch;
X—Westinghouse Micarta sub-panel, 10 by 30 by 3/16 inch;
Y—Hammarlund insulated flexible coupling;
Z—Hammarlund brass extension shaft, 7½ inches long and ¼ inch in diameter;
Gavitt rubber-covered hook-up wire, screws, nuts, brackets, etc.



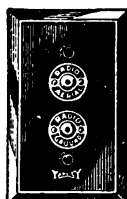
Junior Rheostats

Made to a high standard. Rugged and dependable. Large radiating surface. Only $1\frac{3}{8}$ inch diameter. Standard ratings. 75c



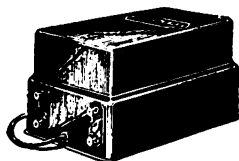
Insulated Phone Tip Jacks

In two colors. Red for positive and black for negative. Indispensable for use with power tubes. Per Pair.. 25c



Radio Convenience Outlets

Singly or in gang combinations for all radio house wiring. Fit any standard switch box. The No. 136 Aerial and Ground is illustrated.. \$1.00



Full Automatic Power Control

For switching both the charger and B eliminator and also for automatically cutting out the A charger when the A battery is fully charged. No. 440..... \$7.50

YAXLEY

APPROVED RADIO PRODUCTS

Distinction Reliability Refinement

All these you add to your set and to your enjoyment of radio, when you make that nice selection of parts which assures you these exclusively Yaxley features.

The Junior Rheostat

will give a velvet smooth touch and a sure, positive, non-fluctuating characteristic to your filament voltage control.

The Insulated Phone Tip Jacks

add a note of real distinction to the appearance of your panel and a feeling of security you have never known before.

The Full Automatic Power Control

assures you always plenty of power for full volume or bringing in the tiny whisper of the distant station, and gives you carefree operation at all times.

Wire Your Home for Radio

with Yaxley Radio Convenience Outlets. Keep batteries in some out of the way place. Enjoy your favorite programs in any room in the house. Bring in antenna and ground without marring the woodwork or trailing unsightly leads either inside or out. For both AC and DC receivers.

For full descriptions and illustrations of these and other Yaxley Approved Radio Products, send for new bulletin.

Yaxley Mfg. Co.

Dept. P-9 So. Clinton Street

Chicago, Ill.



POPULAR RADIO INDEX

of Quality Sets, Kits, Parts and Accessories

A Complete Classified Index of Every Item Required in the Successful Installation and Operation of the Best Radio Apparatus

THESE ARE THE PRODUCTS of the leading manufacturers, combining fine design with high standards of quality in material and workmanship, backed by the unqualified guarantee of satisfaction by reliable organizations of the best character and highest standing. In this connection, it should be realized that no radio receiving set is better than its poorest part or accessory, that a silk purse can't be made out of a sow's ear, and that no buyer can intelligently expect to get more than he pays for. Some of the sets, parts and accessories listed are better than others. In some cases they are larger and more powerful, in others they embody more costly design, more expensive material, finer finish, more skilled workmanship, and for those reasons naturally cost more. But each is the best of its type and in its respective price field. Each represents the maximum of value and actual worth, for which you have the skilled and experienced guarantee of POPULAR RADIO Laboratory, without reservation. You may use these products with confidence, satisfaction and complete success. If you wish more detailed information regarding these products than you find in the pages of POPULAR RADIO, it will be cheerfully and promptly furnished upon request to POPULAR RADIO SERVICE BUREAU, 119 West 57th Street, New York City. Enclose 4 cents in stamps to cover mailing.

Adapters—

H. H. Eby Mfg. Co., Inc.

Aerials (see Antenna)—

Ammeters, (see Instruments, measuring)—

Amplifiers, Low-Frequency, Complete—

American Transformer Co. (Amertran)
National Co., Inc.
Samson Electric Co.

Amplifiers, Low-Frequency Kits—

Samson Electric Co.
Thordarson Electric Mfg. Co.

Amplifier, Power (see Power Packs)—

Antenna Kits—

Cornish Wire Co.

Antenna, Light Socket—

Electrad, Inc.
Leslie H. Muter

Antenna, Loop—

George W. Walker Co. (Victoreen)

Arresters, Lightning—

Belden Mfg. Co.

Base-Boards—

Corbett
Micarta

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Burgess Battery Co.

Battery Chargers (see Chargers)—

Battery Eliminators (see Power Packs)—

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Chassis, Set—

Aluminum Co. of America
Van Doorn

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Leslie H. Muter
Pacient Electric Co.
Samson Electric Co.
Thordarson Electric Manufacturing Co.

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American Transformer Co. (Amertran)
Leslie H. Muter
Pacient Electric Co.
Samson Electric Co.
Thordarson Electric Manufacturing Co.

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N. M. Fleron & Sons

Clips, Test—

Fahnestock

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Hammarlund Mfg. Co.
Gray and Danielson Mfg. Co. (Remler)
Samson Electric Co.

Coils, Coupler—

Aero Products, Inc.
Hammarlund Mfg. Co.
Samson Electric Co.

Coils, Inductance—

Aero Products, Inc.
General Radio Co.

Comparators—

Temple, Inc.

Condensers, Filter—

Acme Wire Co. (Parvolt)
Aerovox Wireless Corp.

Condensers, Fixed Mica—

Aerovox Wireless Corp.

Condensers, Neutralizing—

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Samson Electric Co.

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Hammarlund Mfg. Co.
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Aero Products, Inc.
Crosley Radio Corp.

Cord, Extension—

Belden Mfg. Co.
Gavitt Mfg. Co.

Cord, Flexible Lamp—

Belden Mfg. Co.
Gavitt Mfg. Co.

Cord, Telephone—

Belden Mfg. Co.
Gavitt Mfg. Co.

Dials—

Hammarlund Mfg. Co.
Karas Electric Co.
National Co.

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Grid Leaks, Fixed—

Aerovox Wireless Corp.
International Resistance Co. (Durham)
Arthur H. Lynch, Inc.

Grid Leaks, Variable—

Allen-Bradley Mfg. Co.

Grid Suppressors—

International Resistance Co. (Durham)
Arthur H. Lynch

Harness, AC—

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Gavitt Mfg. Co.
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Impedance Units,

Low-Frequency Amplifying—

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Samson Electric Co.
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Jewell Electrical Instrument Co.
Weston Electrical Instrument Co.

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Westinghouse-Micarta

Insulators—

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Irons, Soldering—

Jacks—

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Pacient Electric Co.
Yaxley Mfg. Co.

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Knobs—

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Microphones, Transmitting—

Milliammeters (see Instruments)—

Oscillators, High-Frequency and Low-Frequency—

General Radio Co.

Oscillographs—

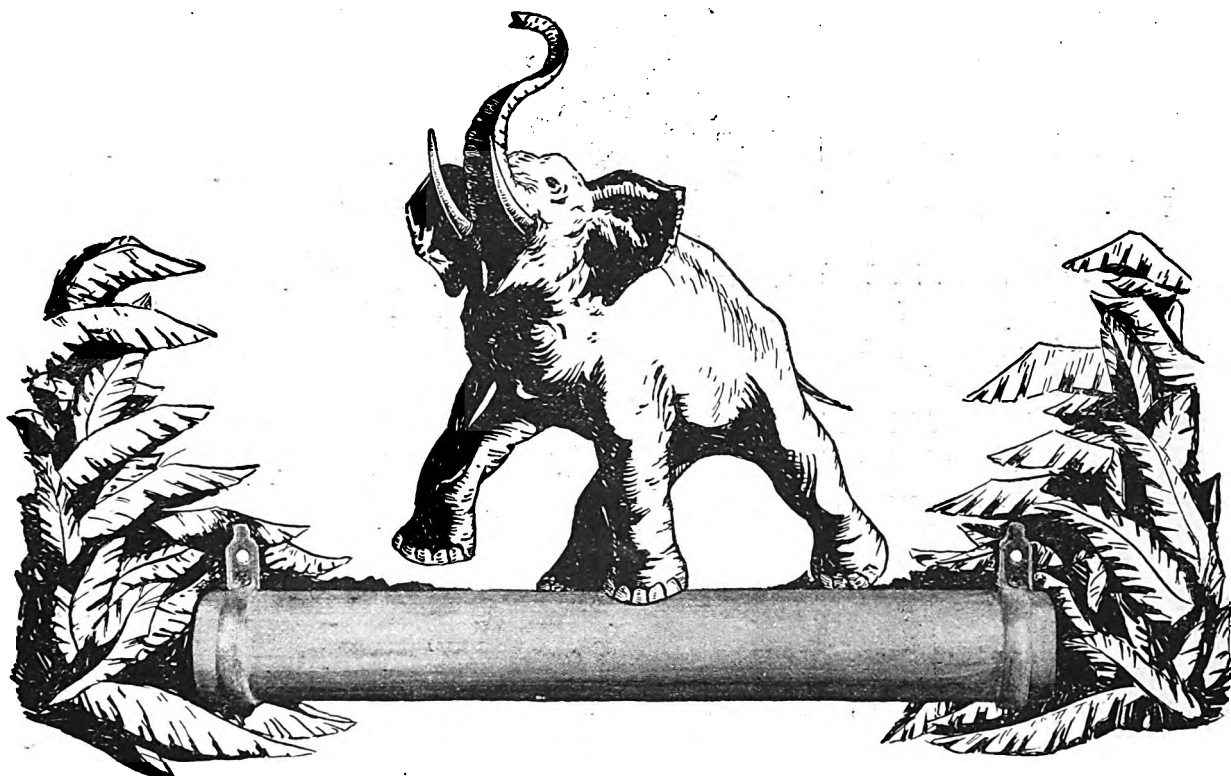
General Radio Co.

Outlets—

Yaxley Mfg. Co.

Output Units, Low-Frequency (see Chokes and Transformers)—

(Continued on page 328)



Carries the Load!

ESPECIALLY drawn resistance layer to insure constancy—Vitreous Enamel baked on for maximum heat dissipation and protection against oxidation and abrasion—Every test science can devise for the assurance of protection. Aerovox Pyrohms are built better—to last longer.

The Aerovox "Research Worker" is devoted to the dissemination of interesting and useful technical data. Send for copy.



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"Built Better"
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They make \$6,000 a year

The facts prove that
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{Signed} C. W. EMERSON
RADIO NEWS

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Transformers, "B" Supply—

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Thordarson Electric Mfg. Co.

Transformers, Filament Supply—

American Transformer Co. (Amertran)
Jefferson (Chicago-Jefferson Fuse & E. Co.)
Karas Electric Co.
Thordarson Electric Mfg. Co.

Transformers, Line Input and Output—

American Transformer Co. (Amertran)
Samson Electric Co.
Thordarson Electric Mfg. Co.

Transformers, Microphone Coupling—

American Transformer Co. (Amertran)
Samson Electric Mfg. Co.
Thordarson Electric Mfg. Co.

Transformers, Power Amplifier Supply—

American Transformer Co. (Amertran)
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Thordarson Electric Mfg. Co.

Transformers, Push-Pull Amplifying—

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E. T. Cunningham, Inc.
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Valves, Amplifying—

C. E. Manufacturing Co. (CeCo)
E. T. Cunningham, Inc.
Donle-Bristol Corp.
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C. E. Manufacturing Co. (CeCo)
E. T. Cunningham, Inc.
Donle-Bristol Corp.
Zetka Laboratories

Valves, Rectifier—

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Donle-Bristol

Voltmeters (see Instruments, Measuring)—

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What's the Most Important Thing that Goes Into a RADIO SET?

Without it no Receiver Can Give the Service You Expect — The Marti Electric Power Radio Has It.

YOU may be one of those thousands of laymen who know little or nothing about the "insides" or "parts" of a radio receiver. All the wires and things you see inside a radio set mean nothing to you.

It follows then that of all the things that go to make a complete radio set the most important of them all is honesty, manufacturing honesty—the will and determination of the manufacturer to eliminate all skimping both in the selection of the parts and in the construction of the receiver.

The Marti's Success

In its scientific design and honest construction lies the success of the Marti Electric Power Radio. The Marti engineers have established the most thorough and severe series of parts tests.

Important Note to the Trade

Heretofore the entire production of Marti Electric Power Radios has been taken by the Eastern market. We are now in a position to make an interesting proposition to high-class dealers and distributors in other parts of the country. Write or wire for complete particulars. See our exhibit at Radio Trade Show, Chicago, June 11-15.

ures up to the Marti standard for that part's particular function. These service-tested, super-quality parts are then assembled on the Marti chassis to function most efficiently, one with the other. The result is an outstanding piece of workmanship, and a quality of broadcast reception as superior to other radio receivers as the tone of a Steinway is to an ordinary piano.

MARTI

ELECTRIC POWER RADIO

Operates Directly From Your House Current Socket

NO [A Batteries
B Batteries
Chargers]

NO [Liquids
Acids
Eliminators]

Not a single part goes into the Marti-Electric Power Radio until it passes these tests and meas-

ures up to the Marti standard for that part's particular function. These service-tested, super-quality parts are then assembled on the Marti chassis to function most efficiently, one with the other. The result is an outstanding piece of workmanship, and a quality of broadcast reception as superior to other radio receivers as the tone of a Steinway is to an ordinary piano.

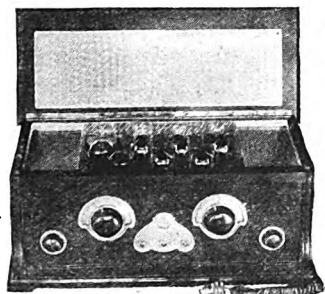
It Mirrors Tone

Judged by the five standards by which any radio set should be judged—tone quality, volume, selectivity, dependability and simplicity of operation—the Marti Electric Power Radio will win your decision. The Marti reproduces the broadcast program naturally and without distortion. It mirrors tone. Illuminated dials permit of hair line tuning and the construction of the Marti assures dependable performance and long service. Electric power from your house current eliminates all "A" and "B" batteries, chargers and other bothersome accessories. Just turn on the switch—that's simplicity of operation.

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Ask your dealer to let you hear the Marti Electric Power Radio. If he hasn't one in stock, write us for circular and address of nearest Marti dealer.

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WEST ORANGE, NEW JERSEY



The Marti Receiver is light and compact. Entirely self-contained—everything within genuine solid walnut cabinet. The two transparently illuminated dials—one for each hand—permit hair line tuning. And so highly selective is this Radio that you can tune in on any program that suits your fancy and be sure of perfect reception without interference.

Models up to \$390.00
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you can learn how to remodel your set for better radio reception. Send coupon or see your dealer.



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Improve Your Radio!

This Book Shows How

Remodeling your set for clearer reception and more realistic tone quality is easy and inexpensive with the help of this book on the value of resistance in radio. Wiring diagrams, charts and specifications show you how to be your own radio mechanic.

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The Long and the Short of Aerials

(Continued from page 317)

In some instances long spikes driven through the pole and into a suitably placed chimney, together with a little wire reinforcement, is all that is necessary to hold the pole upright. In other instances a projecting pipe may give the necessary support. In the event that there is no available support at hand, it will be necessary to supply a small base which may consist of a plank about two feet long, a foot wide and an inch or more thick. A spike may be driven through the middle of this board into the bottom of the pole. The pole may then be raised and held in position by means of three iron guy wires. It will not be necessary to nail the plank support to the roof because of the pulling effect of the guy wires.

The position of the second pole having been previously determined, it may be securely fastened to some suitably strong projection from the roof, as before mentioned, or the guy wire and foot plank method previously described may be used for the second pole. It will be necessary to use an insulator with its attendant short piece of wire to fasten it to the top of the pole. With both the antenna masts erected, the free end of the antenna wire should be threaded through the free end of the insulator. With the free end of the antenna wire make several turns about the antenna wire proper, close up to the insulator, so as to prevent looseness of the antenna.

It will now be necessary to cut off the remaining antenna wire at a distance approximately four feet from the roof. To this free end of the antenna the lead-in wire should be attached. It is preferable that this connection be soldered. If soldering is inconvenient, a joint of approximately six inches in length should be made and this joint should be tightly wound with electric tape to a point extending an inch or two beyond the joint proper. One of the wall insulators should be fastened in the top of the coping at the edge of the building where the lead-in wire is going to be brought down the side of

the building. If possible, it is advisable to utilize one of these wall insulators at a distance of about every twenty feet of the lead-in length. This is necessary because of the fact that in wet weather the brick wall makes a much better ground than in dry weather; and any slight swinging of the lead-in wire tends to change the capacity of the antenna, with a corresponding difference in the antenna tuning. This might produce a slight fading effect of signal strength in wet weather.

The method of bringing the antenna into the house will vary with the type of window used. In the event of metal casing, it will be necessary to utilize a lead-in strip. This consists of a flat piece of copper with a suitable attachment at each end and with the center of the strip insulated. The window may be closed upon this strip after the lead-in wire has been fastened to the outside terminal of the lead-in strip. The inside terminal of the terminal strip may be fastened to a suitable insulated wire running to the set. This wire should be led along the baseboard in the direction of the radio set with double tacks at two- or three-foot intervals to insure it staying in position. The ground wire may be fastened to the ground binding post on the radio set and then led around the baseboard in a manner similar to that used with the lead-in wire. In the event that these two wires go in the same direction for even a short distance, they should be separated about 6 inches from one another. One wire may be led along the top of the baseboard, while the other may be led along the baseboard next to the floor. The ground wire should be soldered to a ground clamp, which is a short piece of strip copper suitable for clamping around a radiator steam pipe or a water pipe.

Remember this: "A good antenna hitched to your set is like an extra stage of high-frequency amplification." You will get better distance and more reliable local reception if you do a good job in the beginning.

1928 Reproduction from a 1910 Phonograph

(Continued from page 302)

sion cord of the reproducer should be placed on opposite sides of the back of the cabinet to prevent hum.

When once installed all that is necessary is to place the vacuum valves in their respective sockets, as follows:

A CX-381 type rectifier valve is to be used in the high-power box. A CX-327 type valve is to be used in the first socket of the amplifier, and two CX-310 type power valves are used in the two last sockets of the amplifier. One

socket on the amplifier is left unused.

Next turn "on" the switch on the front of the power box and after a period of a half minute the amplifier should begin to function. The complete job needs no batteries and runs completely from the AC lines.

It is best to install the reproducer on the opposite side of the room and for this purpose a Gavitt extension cord may be used between the phonograph and the Browning-Drake reproducer.

Super-Simplified Receivers

(Continued from page 310)

a 250,000-ohm resistance, but as the current in the plate circuit is only a small fraction of that flowing through the filament circuit, the voltage drop will not be nearly so great, so we have the plate of the second valve positive with respect to its filament.

Turning now to the potential on the grid of the third valve, we find that this is slightly negative to the filament of the third valve, for although it is virtually connected to the mains on the positive side of the third valve filament, yet the voltage is dropped sufficiently through the 250,000-ohm resistance to make it actually negative with respect to the filament as a whole, so that we obtain the requisite degree of grid bias, if the values of the resistances have been rightly chosen.

In the same manner, the grid of the second valve is negative to the filament of that valve, for both the grid and the plate of the first valve are connected, through a choke, to a point on the negative side of the second valve filament. This point, however, is positive with respect to the filament of the first valve, so that the plate of the first valve gets its requisite positive potential. The grid of the second valve is really more negative than the point to which it is connected, owing to the voltage drop through the choke coil.

The valves used all take a filament current of .1 ampere, so that the voltage drop across each 400-ohm resistance is about 40 volts. The last valve has something like 100 volts on its plate, while provision for varying the bias on its grid is provided by the variable tapping on the third 400-ohm unit. The plate of the second valve gets something like 60 volts, while the first valve, which functions as a plate bend rectifier, gets about 40 volts.

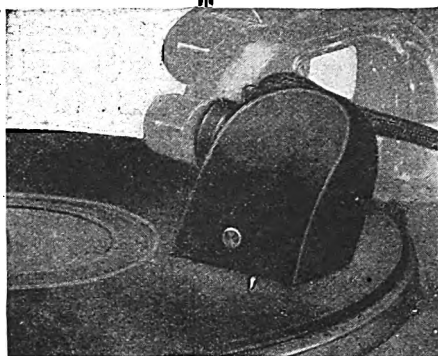
No ground connection is provided in this circuit, for most lighting circuits, if not already grounded, have at least a large capacity to ground.

Some care in the choice of valves for this circuit is necessary. In the case of the first valve, one must be chosen which will function well as a plate bend rectifier at a plate potential of 40 volts. A high amplification valve, such as is designed for resistance-capacity coupling purposes, should be placed in the second socket, and a small power valve should be used in the third socket. These valves must all be of the .1 ampere filament current type, but may be of the 2, 4 or 6-volt class.

This unique circuit is perhaps hardly suitable for use with standard 110-volt AC circuits, but is of interest to the experimenter, as being a decidedly novel departure from orthodox practice, and those who have sufficiently high voltage lines available may like to try it out.

Utilizes your radio to play
phonograph records—

ELECTRICALLY!



List Price
\$10.50

complete for
either A. C.
or battery
model.

*Sold and
demon-
strated by
Radio and
Phonograph
dealers
everywhere.*

Pacent

PHONOVOX

THE Electric Pick-Up

THE thrills—the enjoyment of hearing your favorite records played the new way—ELECTRICALLY—with a superb cathedral-like tone quality of reproduction, may now be yours at a small cost by simply attaching the Pacent Phonovox to your radio and phonograph.

The Phonovox is made in both the battery and A. C. models for sets using the UY227 or CY327 A. C. detector tubes—and either model may be attached in a few seconds' time without tools or making any changes in wiring.

Ask your radio or phonograph dealer
for a demonstration.

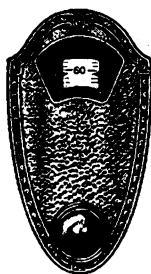
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Makers of the famous Pacent Balanced Cone

Manufacturing Licensee for Great Britain and Ireland:
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NEW in design, but with the familiar NATIONAL Velvet-Vernier Tuning. Made to use and to last. Full 360 degree motion.

Visible portion of dial inclined upward for easier reading.

Easily attached. Ask for Type F.—Price \$4. Type 28 Illuminator 50c.

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1928

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64 Pages of helpful, accurate information on audio amplification and the ways and means of getting better tone quality.

Here is a book every radio experimenter will want. Page after page of valuable data, all in simple language, easy to understand, easy to apply to your own set.

Push-pull amplification—transformer coupling—output transformers—tube combinations—these are but a few of the subjects discussed.

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93 Types of VITROHM RESISTORS Cover Every Radio Requirement

Circular 507, describing Vitrohm Radio Resistors, and "Vitrohm News" will be sent you without charge upon request.

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MOUNT VERNON, N. Y.

BIG RADIO CATALOG

From the
"Big, Friendly
Radio House"

NEW 1928 Book
Offers finest, new-
est well-known sets;
parts, eliminators,
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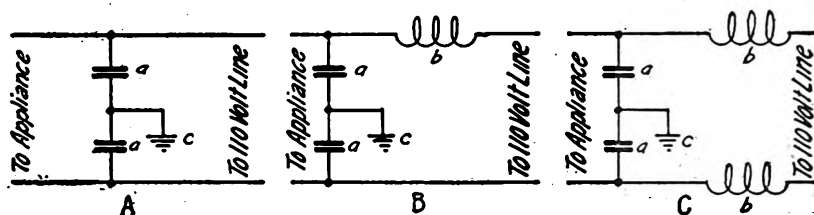
Dealers—
Write for this
Catalog!

**Western Radio
Manufacturing Company**

136 West Lake St. Dept. 54
CHICAGO, ILL.

Running Down the Radio Criminal—Interference

(Continued from page 315)



$a = .5-2$ Mfd. Condenser $b = 2$ MH. Choke $c =$ Connection to Ground.

HOW TO REMEDY A DEFECTIVE MOTOR

FIGURE 1: The condenser method, shown at the left, is usually effective where motors are the cause of interference. Where the device is not remedied by this means, one or two chokes should be put in the circuit, as shown in the two diagrams at the right.

is that it is easier for the ear to distinguish between zero and some degree of maximum volume than between various degrees of maximum volume.

Where the trouble is being caused by a motor-driven appliance of any type, it is usually due to defective brushes or commutator. If arcing at the brushes occurs, first see that the brushes are properly adjusted. If the commutator is dirty or grooved, it may be cleaned by sandpapering it with very fine sandpaper. Under no condition should emery cloth be used, since more harm will be done than good. Where the commutator is badly grooved, it should be turned down in a lathe. This is an operation which will require the services of an experienced electrician.

Another means of eliminating interference of this type is to use one of the methods shown diagrammatically in Figure 1. Usually most cases can be cleared up by using the method shown at "A." In more stubborn cases the methods shown at "B" or "C" will be necessary. There are several types of the filter units shown in these diagrams manufactured by well-known manufacturers, that are now available. These are properly designed and their use is recommended. If these are not obtainable condensers of suitable rating can be purchased and the choke coils can be constructed according to the data given below.

Choke Coil Data

For a single-layer, air-core solenoid whose length is considerably greater than its diameter, substitution of the proper values in the following approximate formula will give a two millihenry inductance:

$$\frac{a^2 n^2}{b} = 20,000$$

where a is the radius of the coil in inches, n is the number of turns, and b is length of coil in inches.

For a multiple-layer coil of the same type, the following formula, also approximate, will serve:

$$\frac{a n^2 (a - 1/3c)}{b} = 20,000$$

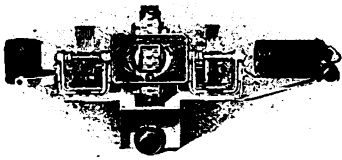
where a , n , and b are as before, and c is the depth of the winding in inches. A 200-turn coil wound on a 3-inch non-metallic spool will give roughly two millihenries.

In vibrating types of appliances, such as battery chargers, a one-half or one microfarad condenser, connected across the contacts, will usually eliminate sparking and stop such interference.

It is essential in hunting trouble by volume indications that the same distance from the line be maintained at all times. Approaching closer to the line will naturally cause more volume at such points. Frequently the volume will drop, and no doubt the operator will find that instead of going away from the trouble as he suspects, the line has crossed from one side of the street to the other. Where lines change from overhead to underground, or at poles where ground wires lead down from pot heads or other equipment, volume will also be greater. Low service wiring or coupling to telephone cables, trolley tracks, etc., or any metal object will in most cases produce the same result. At street corners where branch wiring exists or places where there are more wires volume may also be greater. It is essential, therefore, that allowance be made for these conditions.

There is still another condition that is worth mentioning. Peaks in signal strength or "bumps," as they are called in the parlance of the linemen, will be noticed in following a line. These will usually occur in the center of a span and be equally spaced. If a careful check is made it will be noticed that they increase in volume as the source of interference is approached or decrease when going from the source of interference.

A survey of many thousands of complaints on the part of the power companies has brought to light another interesting fact. Most severe interference occurs in cold dry weather. In wet weather, contrary to general belief, trouble is far less bothersome; and in many cases severe interference will practically disappear.



The Official Browning-Drake Kit

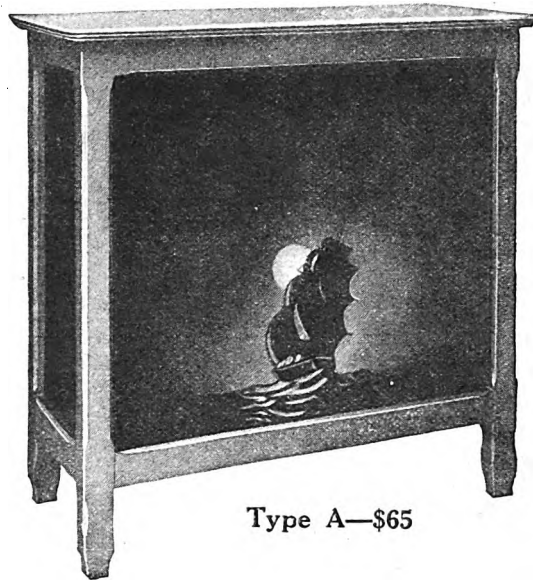
EVER since 1924 Browning-Drake has been the largest selling Kit each year. Those whose technical training permits complete investigation have long known the reason for its popularity. A real scientific advance formed the basis of its success, the importance of which is well shown by the fact that the industry has generally approached Browning-Drake transformer design.

The new Official Kit, pictured above, is the heart of any Browning-Drake set, A.C., D.C., or shield grid.

Your inquiry will bring full information on Kits and factory-built receivers.

A new constructional manual may be obtained either from your dealer or direct, for 25c.

A New Loud Speaker!



Type A—\$65

The Browning-Drake Speaker

ENGINEERS of the Browning-Drake Corporation have recognized in this new speaker the nearest approach to fidelity in musical reproduction yet offered and feel privileged to place it on the market as a Browning-Drake product.

Several new principles of acoustics, developed by W. B. Whitmore and manufactured under Whitmore (Air-Chrome) patents pending, are embodied in this speaker.

Table Model A, illustrated above, is offered in either walnut or mahogany, Duco finish. Wall Model C, artistically designed for an out-of-the-way corner, will be ready April 1st. List price \$38.00.

Dealers: A unique merchandising plan is offered in selling these speakers. Write to our nearest branch and get the details. Speakers in stock at branch offices.

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110 Brookline Street

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the new

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A. C. Counterfonic Six and Power-Pack

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from House Current

The Harkness A. C. Counterfonic Six always operates at highest efficiency... no run-down batteries... no acids... no humming eliminators... but a REAL A. C. radio set with A. C. TUBES... the finest tone quality you ever heard... and so selective and sensitive that distant and local stations are equally at your command.

Secret of its Tone Quality

Harkness "TUNED DOUBLE IMPEDANCE" Audio Amplification used in the A. C. Counterfonic Six gives amazingly realistic reproduction... the entire range of audible frequencies is reproduced uniformly... tremendous volume, when wanted... no distortion, tube-blocking, motor-boating or other annoyances found in less efficient amplifiers.

Single Dial Control

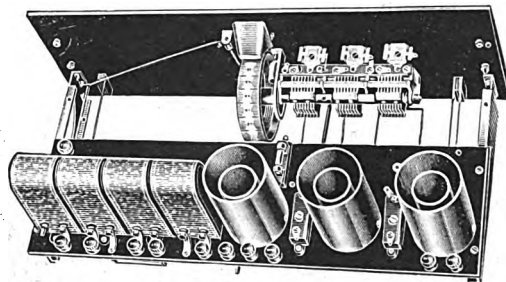
One electric-lighted dial controls three sharply tuned circuits, shielded and neutralized by my own system, perfectly balanced at all broadcast frequencies... interstage coupling eliminated without reducing the sensitivity of the receiver in any way.

Be My Local Sales Representative

Mail the coupon today and reserve exclusive protected sales territory for yourself. I can help you make BIG MONEY for every hour of your spare time, or increase your income if you're already in the radio business.

I want one live, energetic man in each community to demonstrate and take orders for the new HARKNESS A. C. Counterfonic Six. The set sells itself. You make a fine liberal profit on every sale; the buyer gets the finest set that money can buy for LESS THAN HALF the price of a good factory-built set.

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Complete Kit....all
parts required to
build set, exclusive
of Power-pack

List Price

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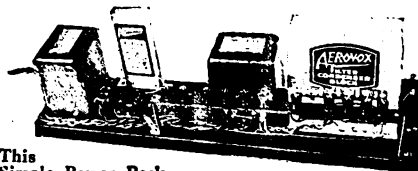
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The Screen Grid LC-28

(Continued from page 296)

terminal at the top of the screen grid valve; this connection may be easily made in the form of a looped piece of bared hook-up wire soldered in a circle and slipped over the terminal cap at the top of the screen grid valve.

How to Install and Operate the Screen Grid LC-28

The receiver may be installed in its Corbett cabinet, as usual. Three CX-322 type screen grid valves should be placed in sockets P1, P2 and P3, with a standard Zetka ZD type detector valve in socket P4.

The valves recommended for the resistance-coupled amplifier are two CX-340 type high-mu valves in the first two stages, and one of the new CX-350 type super-power amplifier valves in the last power stage. A standard CX-381 rectifier valve is also recommended for use in this amplifier.

The proper connections from the National low-frequency amplifier to the LC-28 screen grid receiver are shown in photo-diagram in Figure 2. This shows all the connections between the Yaxley cable and the binding posts on the amplifier, as well as the connections to the Knapp "A" power-pack for supplying filament current for all valves except the rectifier and the power valves. These two latter valves will operate directly on alternating current of the proper voltages furnished in the amplifier.

It is very important that a reproducer capable of handling extraordinarily large volume be used with this combination, and the new Air-Chrome balanced-tension reproducer is recommended. It will have to be installed some distance from the receiver, since the volume is so great that it may vibrate the metal parts of the receiver and cause howling, if placed too close. A Gavitt extension cord is recommended for this use. This cord is made of twisted pairs and picks up no hum from the lighting circuits.

For the antenna, a short piece of wire of from four inches to ten or fifteen feet in length may be used for ordinary reception, according to the surrounding conditions in the location where the receiver is used. A light-socket antenna may be employed, if desired, with excellent results.

Of course, a regular outdoor antenna should be used for extreme long-distance work. The receiver has plenty of selectivity even on a large outdoor antenna in a crowded metropolitan area.

The tuning in, the new screen grid model of the LC-28 remains exactly the same as for the original and earlier models, with the various controls operating for the same apparatus as described in earlier articles.

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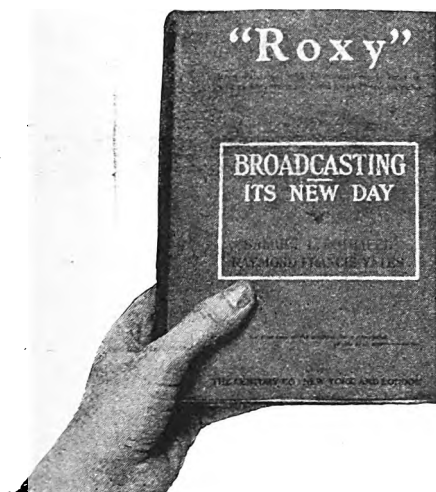
The Service Bureau of POPULAR RADIO is able to place at the disposal of radio manufacturers a list of over 21,000 radio dealers, 3,926 radio manufacturers, 1,746 jobbers and 326 manufacturers' representatives. These addresses are immediately available for circularizing prospects for new 1928 lines, and more detailed information and rates will be gladly supplied to those who wish to take advantage of what is without doubt one of the most carefully kept lists at present offered for use.

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Broadcasting, Its New Day

By

S. L. ROTHAFEL (ROXY)

and

RAYMOND F. YATES

CONTENTS

The Radio Receiver of the Future
Radio Vision
Radio's Long Arm
Power Through the Sky
New Jobs for Radio
The High-Frequency Age
Radio and the Wire Telephone
Can we Talk to Mars?
Broadcasting: Art or Epidemic?
Programs and the Impresario
The Broadcast Drama: A New Art
The Human Side of Broadcasting
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What Can be Done About Interference
The Wayward Child of Commerce
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Hundreds of thousands of fans who listen to Roxy's weekly concerts have often wondered what he really thought of the big problems of broadcasting and the radio art in general. Now, for the first time, Roxy gives his answer to the big radio questions of the day in the most fascinating, edifying and readable book that has ever been published. In his extremely likable way, Roxy gives his impressions of broadcasting. He not only criticizes, but he suggests startling improvements and needed reforms in the presentation of programs. Roxy tells you what he thinks of radio as it effects the impresario, politics, religion, education and commerce. And he answers, once and for all time, that great question: "Where is broadcasting going, and how will it get there?" You will be surprised and amazed by Roxy's original thoughts on what is today the world's greatest form of entertainment.

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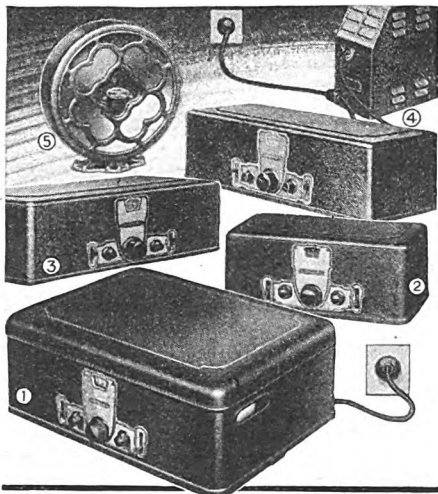
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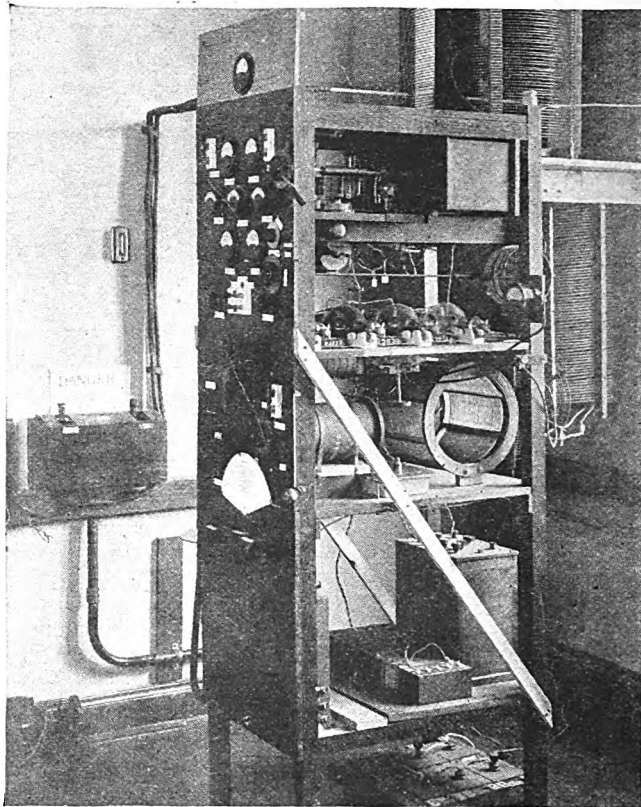
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RADIO

Finding the "Yardsticks" of Radio at the Bureau of Standards

(Continued from page 291)



Bureau of Standards

THE BROADCASTER'S FREQUENCY STANDARD

This 1-kilowatt transmitter is used by the Bureau of Standards for transmitting the constant frequency signals by which the broadcasters of the land calibrate their apparatus. Its frequency range is from 125 to 6,000 kilocycles.

months, an experimental trial of daily broadcasting of market reports. The extensive market report system of today was established on the basis of the results of this trial. For a period of some months early in 1920, before any broadcast stations were established, the Bureau broadcast music experimentally on an announced schedule. Some of this music was taken from phonograph records directly by a microphone, no sound being produced; this principle has been applied commercially in the past two years in electrical phonographs.

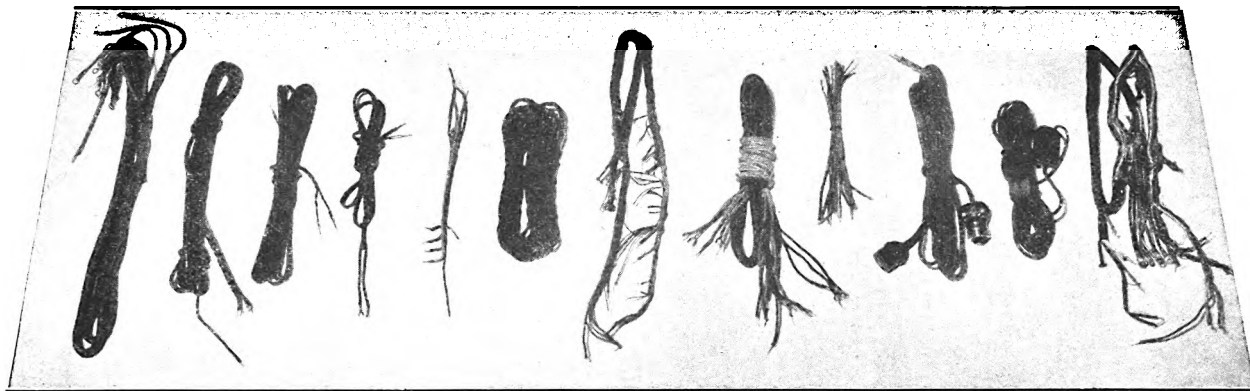
Prior to the year 1923 not only did stations in general depart many per cent from their assigned frequencies, but even the wavemeters used as standards for frequency measurement and control by various laboratories and authorities throughout the country likewise differed by several per cent. It has been the privilege of the Bureau of Standards to contribute materially to improvements in frequency measurement which have made possible more precise station frequency assignments in all the various classes of radio service. This has helped to provide the maximum number of communication

channels in the overcrowded ether.

As an aid in the maintenance of constant station frequencies, many of the broadcasting stations are using piezo oscillators or other forms of frequency indicators. Instruments for this purpose have been developed by the Bureau and have worked out very well in actual use at various stations. The use of a device of this kind is practically imperative to comply with the ruling of the Federal Radio Commission that broadcast frequencies be held within $\frac{1}{2}$ kilocycle.

The Bureau disseminates accurate standards of frequency by regular transmissions of standard frequency signals. For several years it published monthly lists of the stations which it found to hold their frequencies with great constancy. This undoubtedly helped to mitigate the chaos of uncontrolled station operation in 1926.

Another illustration of the direct value to the public of the Bureau's scientific work is the radio beacon system. Certain of the Bureau's researches on antennas led to the development of a very simple and efficient radio direction finder. By rotating this direction finder, while listening to a radio mes-



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HIGH-POWER CORD—This speaker cord has been developed especially for high-power radio receivers having output voltages as high as 1500. Standard tinsel speaker cords are inadequate for use in modern high-powered sets. Our speaker cord is thoroughly insulated with rubber and twisted so as to minimize A. C. hum in the event the cord is laid parallel to lamp or fixture cords. Supplied in 20, 30, 50 and 100 foot lengths.

HOO-K-UP WIRE—Professional and amateur set builders are supplied by the Gavitt Manufacturing Company with a full line of hook-up wire to be had in standard assortments with colored rubber insulation. All Gavitt hook-up wire is made up of No. 18 tinned stock. Each assortment contains five 5 foot lengths.

TINSEL SPEAKER CORDS—Gavitt tinsel speaker cords are strong, durable, and moisture-proof. Their braided coverings are woven tightly and are able to withstand more than normal abuse. Each cord comes with the standard tips. These speaker cords are supplied in 3, 5, and 6 foot lengths; special lengths made to order.

BATTERY CABLES—Gavitt battery cables are being manufactured in a wide variety of types, and they are being used by leading radio manufacturers throughout the United States. Standard types are always in stock and special colors may be made up at short notice. All battery cables are tightly woven and moisture proof and terminals carefully soldered.

A. C. SUPPLY CORDS—The Gavitt Manufacturing Company produces a variety of special cords for A. C. sets. These may be used on "B" eliminators, "A" eliminators, and come complete with special plugs for sockets. Such cords are made according to specification and in any length desired. These types of cords can also be had with polarity indicators or markers.

CHASSIS AND PANEL CABLES—For five years the Gavitt Manufacturing Company has been supplying the principal radio manufacturers of the United States with chassis cables made to suit their own individual requirements. All assembly, braiding and tinning is done at the Gavitt factory and the cables arrive ready for the soldering operation. Only the very best materials are used in these cables.

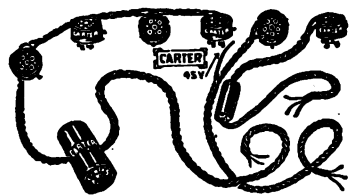
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sage, the direction of the transmitting station is indicated. A ship equipped with the device can steer to a ship which is sending out a distress call, or can locate its own position by the aid of radio signals from shore stations. The Bureau of Standards developed automatic radio transmitting apparatus to send out such signals from lighthouses. The Lighthouse Service has installed these radio beacons at fifty lighthouses, where they serve the same purpose as lights, but do it better because they work over greater distances and in fog. Radio has thus vanquished the terror of fog, the worst enemy of the navigator.

The radio beacon has also been found of service in air navigation. Special types of radio beacons have been developed to keep an aircraft on its course. The rapid growth of commercial aviation will depend heavily upon radio as an aid to navigation, for air navigation is subject to large errors due to wind drift. When fog makes the ground invisible, the aviator is in a serious plight. For this reason the Bureau is now devoting a large share of its effort in radio to perfecting methods to guide an aviator along his course and assist him in landing.

Another radio development for aircraft by the Bureau is a distant control device. This device, a direct product of fundamental research on electron valves, gives a means of navigating a pilotless airplane by radio. The same device has been found useful in operating a radio transmitting station from a distance and in other instances of remote control of machinery.

Some of the Bureau's research work is directed toward the study of wave transmission variations, fading, and atmospheric disturbances. These are seen as large problems, the ultimate solution of which requires much more extended knowledge of the actual behavior of the waves than now exists. This knowledge must come as the result of extended observations. The Bureau is engaged on methods and apparatus for such observations, and works in co-operation with other laboratories on these problems. An early program of such work done in co-operation with the amateurs led to the explanation of fading which was first published by the Bureau in 1921, which postulates that the waves travel at night along the Heaviside layer, or upper region of the earth's

atmosphere, about 100 miles up. In daylight transmission the waves cannot reach the Heaviside layer because of the intervening ionized atmosphere, and hence in daytime the waves travel along the earth's surface, where they are subject to absorption. At night, on the other hand, when the air is much less ionized, the waves reach the Heaviside surface and travel along it. Variations in the Heaviside surfaces or masses of ionized air below it introduce the variable absorption which is evidenced as fading. This theory has been further substantiated by the results of later investigators.

A statistical study of interference to broadcast reception was conducted by the Bureau of Standards with the co-operation of about 200 observers located at distances up to 400 miles from two selected broadcasting stations. Interesting data on distance range and on various sources of interference were obtained. Subsequently, with the co-operation of a 50-kilowatt station, the Bureau determined the effects of high power on service area, blanketing interference, fading, etc.

The results of the Bureau of Standards' radio work are embodied either in publications, which are available to the public, or in reports for Government use.

While the Bureau makes as much as possible of its output available to the public through its publications, it is not, and could not possibly be, a radio question-and-answer bureau. With many evidences of the work of the Bureau of Standards appearing in publications and otherwise all over the country, and with the newspapers assiduously and commendably featuring the day-by-day results of scientific progress, many people have the impression that the Bureau can supply the answers to every conceivable question about electrical or mechanical apparatus. Now it is estimated that there are over 10,000,000 people in the United States using radio, and radio is so interesting that the average user has in his mind dozens of questions the correct answers to which would require a whole course of special training. The author need hardly say that one Government bureau could not supply individual training for this multitude, nor that it would be utterly unable to do its main work if it attempted to answer all the questions that come to it.

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- 4 Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; standard brass end tip type.
- 5 Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; knife-end type.
- 6 Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; soldered end tapped type.
- 7 Durham Powerohm—2½ Watts; 500 to 250,000 Ohms; screw-end type.
- 8 Durham Powerohm—5 Watts; 250 to 250,000 Ohms; soldered end tapped or screw-end type.
- 9 Durham Powerohm—10 Watts; 250 to 250,000 Ohms; soldered end tapped and screw-end type.
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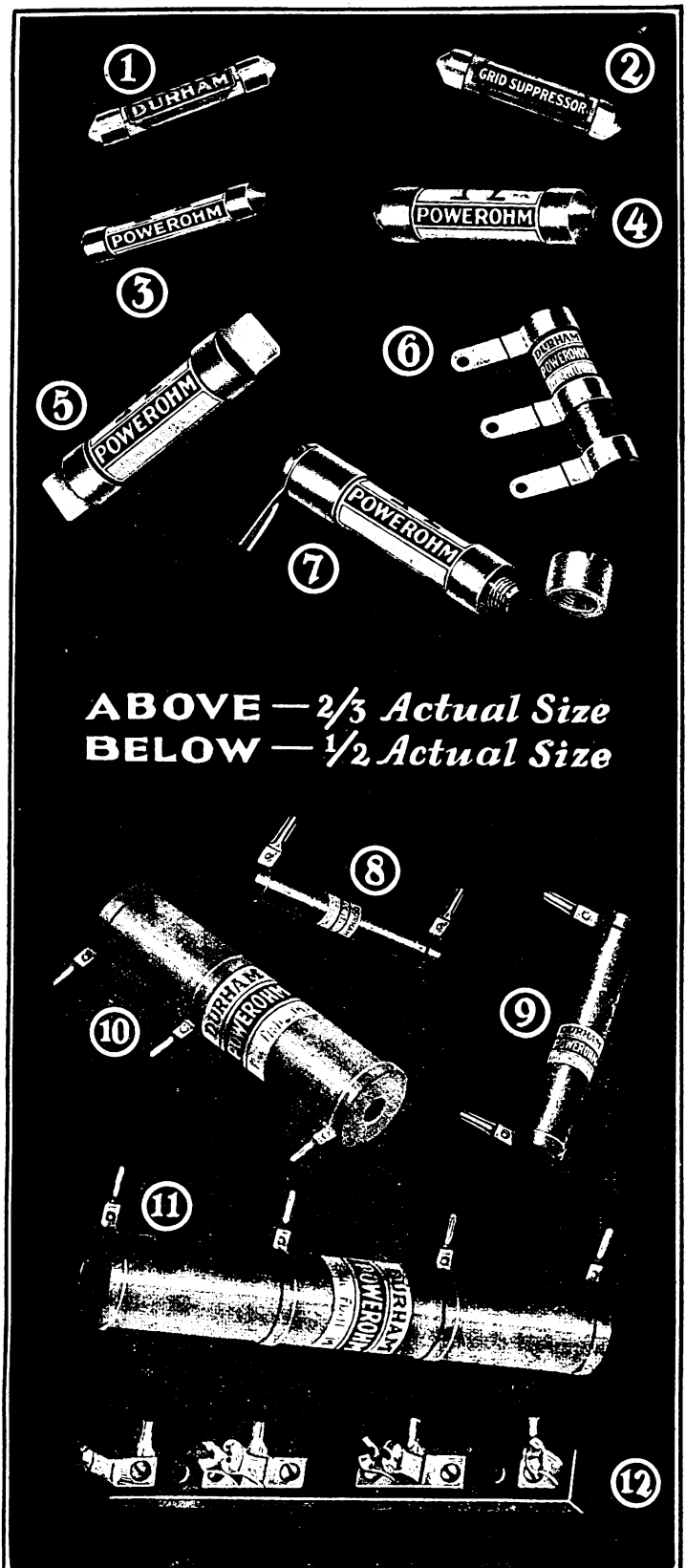
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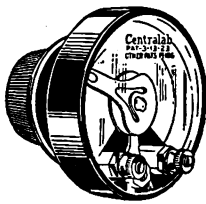
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One of these two Radiohms and the Centralab Power Rheostat are essential resistances for all "AC" circuits. They help to maintain the delicate balance of voltages throughout the circuit and in no way affect the balance between plate and filament current, so necessary to maximum efficiency.

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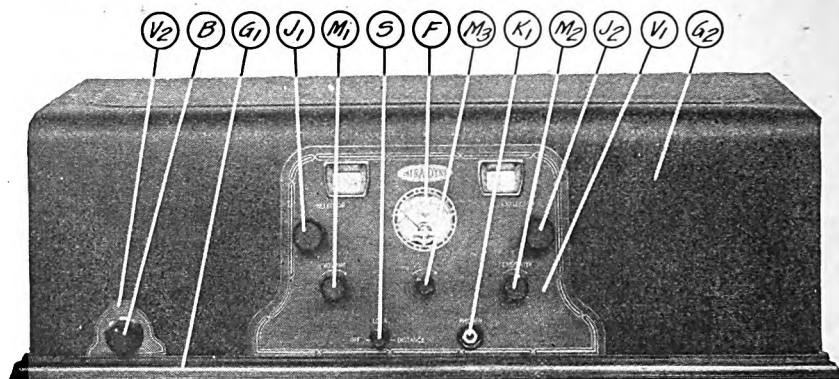
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Plenty of New Ideas in the Remler Infradyne

(Continued from page 289)



THE PANEL CONTROLS

FIGURE 6: Although the panel controls seem rather complicated for these days of simplified operation, it will be found that tuning in most stations requires only two controls. The other controls are for use in bringing in extreme distances.

sockets U2 and U3, at the extreme right-hand end of the base. Place a CX-371 type valve in socket U4.

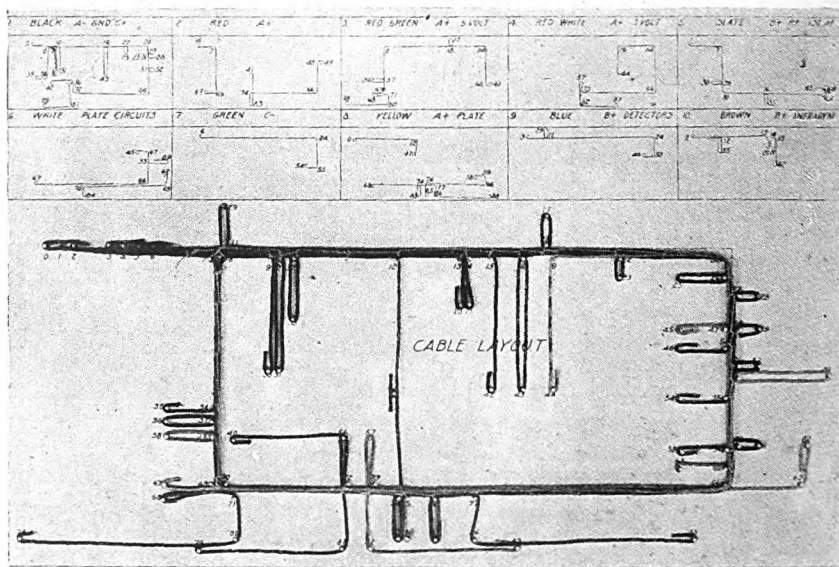
In connecting the batteries the red and black wires in the battery cable should be connected to the positive (+) and negative (—) terminals, respectively, of a 6-volt storage battery. Turn the switch, S, to the "local" position. All of the valves except those of the CX-299 type and the CX-301-a type valve at the extreme right-hand end of the base in socket U2 should light. The pilot light over the left-hand dial should also light. Now turn the switch to the "distance" position, and adjust the panel rheostat, M1, so that the voltmeter registers 3 volts; all of the valves in the set and both pilot lamps should now light.

Next connect up the "B" and "C" batteries, as shown in photo-diagram in Figure 5. Connect up the antenna and

ground and plug in a pair of phones into the jack on the control panel. Set the inner part of the antenna compensator knob at "3" and adjust the outer part of the antenna compensator so that the moving coil makes an angle of about 45 degrees with the stationary coil. The left-hand tuning dial should read "zero" with the plates of the condenser in the high-frequency amplifier "wide open." Turn the volume control about 4/5 of the way "on" and rotate the left-hand dial slowly until a station on about 200 meters is picked up.

The balancing condenser connected across the antenna section of the gang condenser in the amplifier, A, should then be adjusted for the loudest signals. Fasten down the cover of this amplifier and the adjustment of the infradyne amplifier can be begun.

First see that the right-hand dial reads "100" when the plates of the con-



THE CABLE LAYOUT

FIGURE 7: This picture is a reproduction of the paper template that comes with the foundation unit, with the cable properly laid out upon it by means of nails.

denser are "wide open." Using the wooden wedge furnished with the amplifier turn the four infradyne amplifier tuning controls to "zero" and turn the infradyne amplifier "increase" screw about $\frac{2}{3}$ of the way "down," using the fingers instead of pliers. Then turn the switch on the front panel to the "distance" position and set the panel rheostat to exactly 3 volts. Set the left-hand dial for a station in about the middle range and set the "sensitivity" control to a point just beyond which a series of whistles is heard as the right-hand tuning dial is turned. The "increase" screw should be adjusted so that the whistles appear when the "sensitivity" control has been advanced about $\frac{1}{3}$ of its range. Next rotate the right-hand dial until the station for which the left-hand dial is adjusted is brought in.

Consider the infradyne amplifier tuning controls reading from left to right as numbers 1, 2, 3 and 4. Leave No. 2 set at "zero." Adjust No. 3 for maximum signal strength, while rotating the right-hand tuning dial slowly back and forth past the station setting. Next rotate knob No. 1 for maximum signal strength and then adjust knob No. 4, coming back to knob No. 2 for a final adjustment. As the proper settings are found the amplifier will probably go into oscillation and a whistle will be heard as the station setting is passed. If this happens, turn the "sensitivity" control back until it ceases.

In operating the infradyne several pointers should be kept in mind. When the switch is in the "local" position only the left-hand tuning dial and "volume" control should be used. With the switch in the "distance" position the "sensitivity" control and both tuning dials will be used, in addition to the "volume" control. The voltmeter should always indicate 3 volts.

The two tuning dials should read nearly alike over the entire range.

When all of the adjustments have been made we are ready to put in place the metal cabinet, G1.

We now have a receiver which needs no further adjustment and is amply selective to cope with any local broadcast conditions.

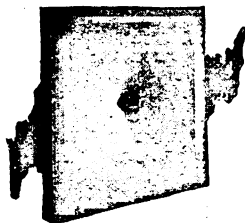
By turning the switch to "local" the economy of operation is greatly increased, and by turning it to "distance" the man who wants "DX" will find all he wants in the way of sensitivity in fishing after far away stations.

Home-made Static

"WHAT part does Jenkins sing in your glee club?"

"I can't quite figure out, but I am about convinced he just adds the static to make it sound as if our selections were coming in over the radio."

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The speaker without cabinet
24"x24" diaphragm \$25.00

The AIR-CHROME speaker represents a new field of engineering—the greatest frequency range for commercial speakers—and power without "blasting" or "rattling."

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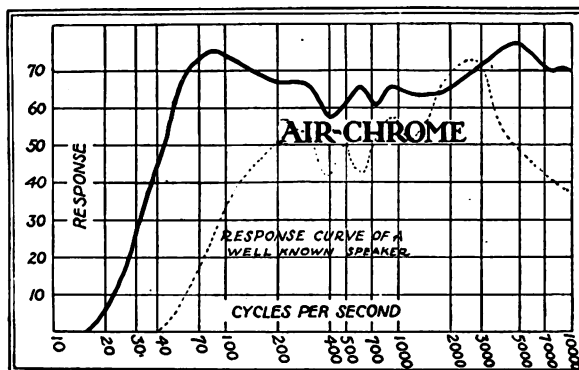
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The Air-Chrome SPEAKER

Operates on New Balanced Tension Principle



The Air-Chrome Studios

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HOW'S BUSINESS?

EVERY day more custom made set builders and service men are qualifying as RADIO TECHNICAL MASTERS.

They are finding the available technical and merchandising service both helpful and profitable.

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The Sky is the Limit!

BRAND NEW IDEA FOR A RADIO PARTY

The Mystic Home Broadcaster takes only a minute to insert. No skill required. Hide in another room or closet; sing, joke, play into the microphone.

THEN THE FUN BEGINS.

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Send No Money

Pay postman \$4.95 plus postage for microphone, special extension cord, adaptor plug.

Money back guarantee.

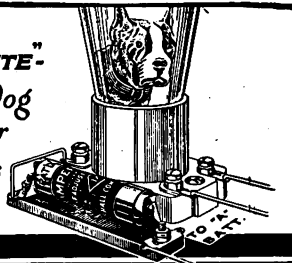


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Be Your Own Broadcaster

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"AMPERITE"
Watch Dog
of Your
Tubes



Simplifies-

1. Tube control—No knobs
2. Wiring—Short leads
3. Panel design—No drilling
4. Tuning—No hand rheostats

Only AMPERITE can automatically keep the temperature or voltage of the filament constant despite variations in "A" battery voltage. Particularly essential with eliminators. Proved for 6 years to be indispensable in every radio circuit. Do not confuse with fixed filament resistors. Accept only AMPERITE. Price \$1.10 with mounting (in U.S.A.). At all dealers.

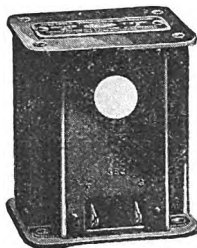
Write for Free "Amperite Book" of season's best circuits and latest construction data. Address Dept. P. B. 4

Radiall Company
50 FRANKLIN ST., NEW YORK

AMPERITE
REG. U.S. PAT. OFF.
The "SELF-ADJUSTING" Rheostat

PRECISION!

Sangamo engineering of Audio Apparatus is followed up by precision production methods gained in nearly 30 years' precision instrument manufacturing. In Sangamo Transformers and Impedances the set builder and manufacturer is thus assured of that precise matching of each unit to the designated tube so necessary for superior tone quality.



The "Yellow Spot"

Designates the Sangamo Type "A" Audio Transformer used for cascade amplification. This transformer has the flattest curve (most uniform amplification at all audible frequencies) available in any transformer at the present time. Look for the transformer with the yellow spot.

"Light Blue" The Light Blue Spot identifies the Sangamo Input Transformer for push-pull amplification. Has high inductance primary to secure high amplification on low frequencies. Accurately divided secondary gives almost identical frequency characteristic curve on each half. "Type B"—known by the light-blue spot.

"Dark Blue" Output Transformer for push-pull amplifier having an impedance to match UX-210, CX-310 and UX-112, CX-112 tubes. Maximum transference of energy on low end of the musical scale.

"Green" Same as above except impedance matches UX-171 and CX-371 tubes.

"Red" The Red Spot designates the Sangamo Type "E" Output Impedance, keeps heavy D. C. "B" current from loudspeaker windings. Tap provided for matching impedance to UX-171 (CX-371) or UX-210 (CX-310) tubes, also UX-112 (CX-112).

"Orange" Used for impedance coupled amplification, auto-transformer coupled amplification, or as impedance in plate circuit of detector tube to prevent feed-back, oscillation or "motor-boating" in transformer coupled amplifier.

Also makers of Sangamo Mica Condensers, moulded in Bakelite—made accurate and stay accurate.

SANGAMO
ELECTRIC COMPANY
Springfield, Illinois

Use the PR Converter for Television Wavelengths

(Continued from page 309)

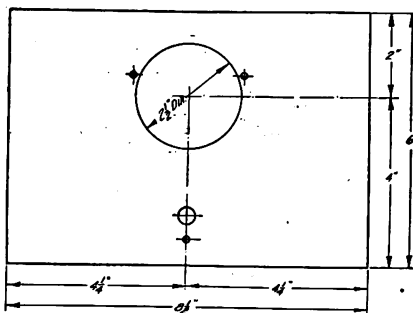


FIGURE 4: THE DRILLING PLAN FOR PANEL I1.

of the aluminum shield for mounting the drum dial, D, as shown in Figures 2 and 4. The direction sheet and template packed in the carton with this dial should be followed out in mounting this tuning dial.

Next drill the top panel, I2, as shown in Figures 2 and 5, for mounting the coil frame, the socket, E, and the choke coil, B. Also drill the four holes for passing through the necessary connections from the coil frame to the instruments mounted within the box shield. The coil frame is fastened to this panel by means of two machine screws and nuts. Looking at the front of the top panel, the machine screw on the right-hand end of this coil frame should be passed through to the socket, E. This one screw is used for fastening both instruments. The other side of the socket, E, is attached to the top panel by means of a machine screw and nut.

Next fasten the choke coil, B, to the top panel with the mounting bolt and nuts provided with this instrument.

Now drill the side shield, I3, for mounting the neutralizing condenser, H. A hole about $\frac{3}{8}$ inch in diameter should be drilled in the upper left-hand corner of this panel for passing through the twisted leads of the connector plug. The neutralizing condenser, H, is fastened to this side panel by means of two machine screws and corresponding nuts. Two spacing washers approximately $\frac{1}{4}$ inch thick should be inserted between this instrument and the panel.

Next fasten the grid condenser, F, that is equipped with grid-leak clips, to the grid terminal of the socket, E.

The tuning condenser, C, is attached to the drum dial, D, by means of the special bracket furnished with the dial.

How to Wire the Short-Wave Converter

The picture wiring diagram in Figure 2 shows the instruments in their correct positions. The instruments mounted within the box shielding are outlined in solid black lines, while the coil assembly, A, which is mounted on top of the box shield, is shown in dotted lines.

The same holds true of the wiring.

The heavy red wires are the connections to the instruments within the box shield and the dotted lines are the connections to the coil assembly, A.

The connector plug may be made from the base of a burnt-out UX type of valve. Remove the glass and other matter from the base and solder the two filament leads and the plate lead of the connector plug to their respective prongs. To avoid mistakes, check these instructions against the detail drawing in Figure 2.

When the wiring has been completed, the grid-leak, G, should be inserted in the grid-leak clips and the sides of the box shield should be inserted into the of the aluminum shield for mounting fastened with the aluminum screws.

How to Install and Operate the Short-Wave Converter

The antenna and ground connections are taken off the Hammarlund-Lynch "5" receiver, or any standard broadcast received with which this unit is to be used, and applied to the antenna and ground posts of the converter. Next insert the connector plug of the short-wave converter into the detector socket of the broadcast receiver. For details of connection, refer to Figure 3.

The vacuum valves recommended for the short-wave converter and the Hammarlund-Lynch "5" receiver are as follows: A Zetka ZD valve in the valve socket of the converter; two CeCo Himu valves in the first and second low-frequency stages and a CeCo type valve in the last low-frequency stage in the Hammarlund-Lynch "5" receiver.

The filament voltage of the valve in the short-wave converter is controlled from the filament voltage source used in the broadcast receiver.

The primary of the coil assembly, A, should be loosely coupled to the grid coil. All tuning is done with the variable condenser, C. Regeneration is controlled by the neutralizing condenser, H. This regeneration control should be adjusted for most satisfactory reception at each particular wavelength received.

The various short-wave ranges may be covered by interchanging the coils. It is recommended that a log be kept of the dial setting and coil used on each station received.

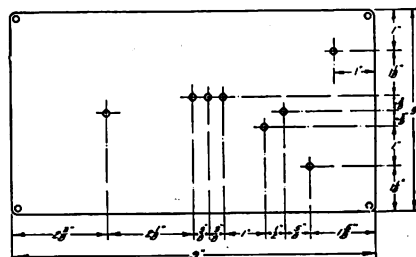


FIGURE 5: THE DRILLING PLAN FOR PANEL I2.

The Individual Tube

THE ZETKA PROCESS SPECIAL DUTY TUBES

This new line of tubes—to deliver the results of which they are capable—require proper operation.

We are trying to restrict their distribution to Dealers who cater to "Fans," Amateurs, Professional Set Builders and Service organizations—the "RADIO-WISE" buyers who handle laboratory products most intelligently.

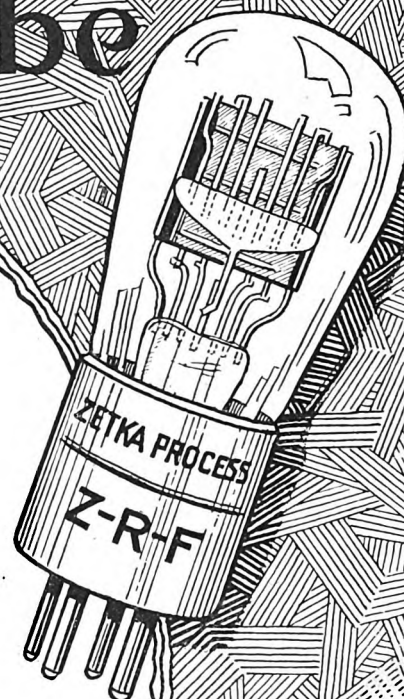
If your dealer cannot yet supply you, we will appreciate your sending us his name and address. In the meantime, we will fill your order direct on receipt of your check or money-order—or C. O. D., if you prefer.

—ZETKA PROCESS SPECIAL DUTY TUBES are guaranteed to give complete satisfaction in your receiver provided they are operated according to the instructions accompanying each tube.

ZETKA LABORATORIES, Inc.

67-73 WINTHROP ST
NEWARK, N. J.

ZETKA
CLEAR GLASS TUBES



Z-R-F—Radio Frequency Amplifier, 5 volts, $\frac{1}{4}$ amp. High amplification constant. Low plate impedance, and low internal capacity. Uses 90 volts on plate....Price \$4.50

Z-D—Super-sensitive Detector. 5 volts $\frac{1}{4}$ amp. High amplification constant. Silent (no hiss) Uses 45 volts on plate.....Price \$4.00

Z-A-F—Audio Frequency Amplifier. 5 volts, $\frac{1}{4}$ amp. Higher Mu, low impedance. Plate voltage 90 to 135 Price \$4.50

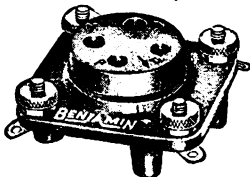
Z-A-O—Audio Output, or Power Amplifier. 5 volts, $\frac{1}{2}$ amp. For handling large output volume without distortion. Plate voltage 180, with 22 $\frac{1}{2}$ volts "C".....Price \$4.50

BENJAMIN**Cle-Ra-Tone Sockets****Red Top**

For Standard UX Type Tubes. For quick and easy finding of the correct position of the tube and the prongs.

Green Top

A new Five Prong Socket for A. C. Detector Tubes. Especially designed for heavy current-carrying capacity for these new tubes.



You can tell immediately into what socket each tube should go. No more mistakes, hesitation or confusion. Improves the appearance of the set.

Cle-Ra-Tone Sockets are spring supported to absorb the shocks that distort tonal qualities. The tube "floats" on four finely tempered springs, which absorb shocks and jars from slamming doors, passing traffic and other disturbances caused by outside vibrations. One-piece terminal to tube connection. Positive contacts. Knurled nuts for binding post connections or handy lugs for soldering.

Cle-Ra-Tone Sockets have been chosen for practically every prominent circuit for several years.

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RESISTANCE

and BRAKES

STANDARD

CLAROSTAT

Reg. U. S.

Pat. Office

RESISTANCE is to a radio circuit what brakes are to your car. You need good brakes. You vary them according to conditions. You apply them as required.

Do the same with resistance. Use good reliable resistance. Vary your resistance according to requirements—circuit, components, voltage, signal, tubes, tube life and so on.

All of which spells Clarostat—a unique resistance adjustable to meet all conditions, and fixed when conditions have been met.

There is a Clarostat for every purpose—the tiny Volume Control for receiving circuits, Standard type for B-Power voltage control, Power type for heavy-duty units and electrified receivers, and Table type for use as an accessory with any set.

Ask your radio dealer to show you the complete line of Clarostats, and to give you informative literature on how to improve your radio. Or write us direct.

American Mechanical Laboratories, Inc.

Specialists in Variable Resistors

285-7 N. Sixth St.,

Brooklyn,
N. Y.



An "Air Road" Test With the Marti Electric

(Continued from page 316)

ter of fact, POPULAR RADIO did a great deal to inspire the work that eventually led to its perfection; for it will be recalled that as far back as 1924 POPULAR RADIO was quick to grasp the engineering possibilities of the AC valves of the heater type. Mr. Charles Marti, an alert young engineer and follower of POPULAR RADIO, having read of the experiments of the technical staff with these new valves, had sufficient courage and faith to proceed with the design of an all-electric receiver. As a result of his forethought, the Marti All-Electric is now conceded to be among the best receivers of this type.

The receiver makes use of two stages of high-frequency amplification. It is tuned by two illuminated dials, one connected to a single condenser and one to a double. Three stages of low-frequency amplification of the resistance-coupled type are used. Thus, with the detector included, the receiver has six valves. The last stage uses a CX-310 type amplifier valve, which supplies very great volume. This volume is controlled by a knob on the right-hand side of the receiver.

The power unit, that is, the "B" current supply and the filament heater transformer, is incorporated in the cabinet. A switch to accommodate low or high line voltages is also incorporated, together with a provision for using the AC line as an antenna if the user does not wish to go to the trouble of installing an outside wire.

Among the many unusual features of the Marti receiver is the possibility of interchanging the valves. Although the Marti is originally supplied with AC valves having separate heater terminals at the top, in every stage except the last, which uses a 310, any one of the five valves may be immediately replaced with a five-prong heater type valve.

The power unit which supplies the "B" voltage for the 310 and other valves makes use of a CX-381 rectifier valve.

In operating the receiver, it is necessary to know the meaning of the four controls on the panel. As previously explained, two of these are controls for the tuned-high-frequency stages. One is a volume control and the other a switch used for local and long distance reception—really, a high and low gear. This high and low gear, local and long distance switch on the Marti is an innovation which varies the impedance of the plate circuit in one of the high-frequency valves. For local reception sufficient volume will be had with higher impedance, but with distance better results can be obtained with lower values of impedance.

This "air-road" test of the Marti receiver proved to be unusually interest-

ing and somewhat amazing in the matter of results achieved. In tuning, the receiver was found exceptionally sharp; so sharp, indeed, that oftentimes the accuracy of a hair's breadth was necessary to separate the stations in the lower and more confused portion of the radio spectrum. In tuning the Marti, the dial on the right is used first to bring the signal in at maximum loudness, keeping the two dial settings approximately even. The second dial is used to "trim up" and to bring the first tuned circuit in resonance with the other two tuned circuits.

With the control knob on the long distance tap and the volume control about three-quarters of the way round, the Marti provided not only exceptional quality, but very great sensitivity. Even with the increased output of the two high-frequency valves, there seemed to be no indication of undue regeneration or other circuit noises. The AC current hum was conspicuous by its entire absence.

Beginning at 8.15 p.m., the "driver" of this air road test skipped from one side of the country to the other during the course of the evening. In the early part of the evening (New York was the operating center) the following stations were logged:

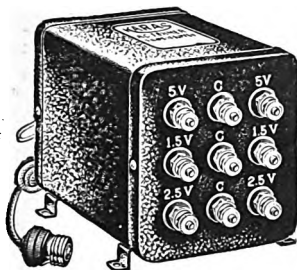
WJAR, WJAX, WEEL, WFI, KYW, WFAF, WJZ, WOR, WAAN, WGL, WGY, WGR, WICC, WTIC, WQAM, WMAK, WHAN, KDKA, WSM, WWJ, WLS, WEBH, WQJ, WGN, WLBB, WBAL, WBZ, WTAG, WWRL, WLWL, WABC, WFBL.

Later on in the evening and during the early morning KOA and KFI were logged under atmospheric conditions that could by no means be considered ideal.

A careful examination of the mechanical details of the Marti All-Electric will convince even the most discriminating engineer that extremely good judgment has been used in producing this receiver. The shielding is of aluminum, with a mottled finish and provided with a ventilating system which carries away the excess heat developed by the 310 and 381 valves. There is an admirable compactness about the whole unit, fixed condensers, resistances, and other necessary appurtenances being very carefully concealed by the shielding. Special flexible spring connectors are used to make contact with the heater elements of the Kellogg valves used. The various condensers and resistances, as well as the high-frequency coils of the Marti, are easily accessible by simply taking the valves out of the receiver and turning the set upside down. Removing the perforated cover exposes the parts and permits easy access to them for repair.

KARAS

stands for QUALITY in the "CUSTOM-BUILT" FIELD!



TYPE 12

Supplies up to
8-226, 2-227,
2-171 tubes.
\$875
List

THE KARAS A-C-FORMER

Converts battery sets to AC operation. Delivers absolutely correct voltage. Needs no separate device for center tap. Has plug-in connection to "B" eliminator, and wire to panel switch. No re-wiring necessary. Operates with Carter, Eby or other cable harness.



KARAS MICROMETRIC VERNIER DIALS

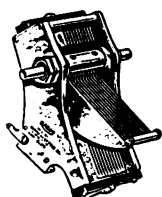
Smooth, velvety action—no back-lash. Vernier ratio—63 to 1; tunes to 1-1000th of an inch. 0-100; 100-0 and 3608. List \$3.50

THE NEW KARAS S. F. L. CONDENSER

The finest product of years of experience. Removable shaft allows for subpanel, baseboard or single hole mounting from either side, permitting use of 0-100 or 100-0 dials.

TYPES

11.....	.00025 mfd.	\$5.00
17.....	.00037 mfd.	5.25
23.....	.0005 mfd.	5.50



KARAS OUTPUT FILTER

Improves reception. Eliminates chattering of speaker. Sweetens and clarifies tone qualities—prevents demagnetization. List \$8.00

KARAS TYPE 28

The world's greatest transformer—perfect reproduction of low and high notes plus tremendous volume! Scientifically impregnated—in a steel-clad spun-sealed case to safeguard its marvelous amplifying qualities. List \$8.00

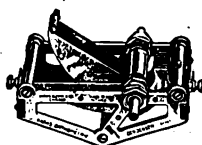


KARAS HARMONIK

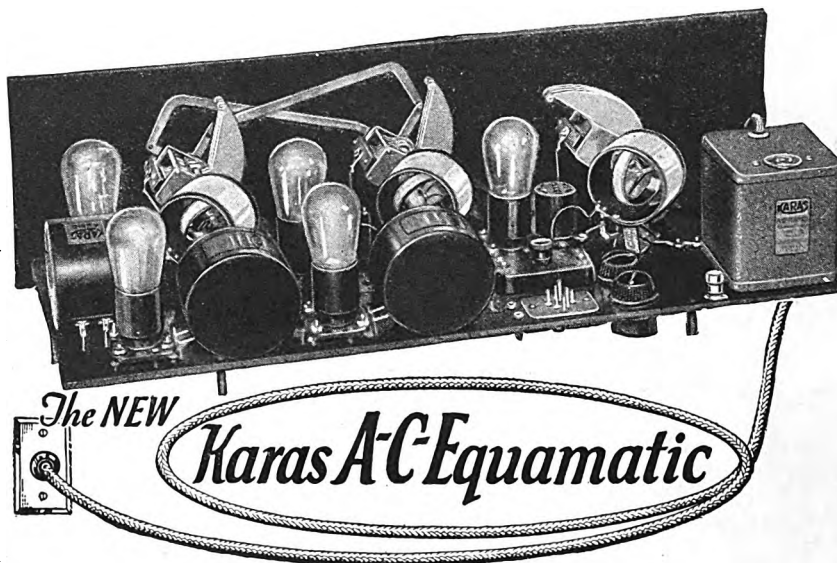
This audio-frequency amplifying transformer delivers most beautiful reception—amplifies with great volume, clarity and purity. List \$5.00

KARAS ORTHOMETRIC CONDENSERS

Separates adjoining wavelengths by equal distances on the dial.



5 plates—	.0001 mfd. capacity.....	\$6.50
7 plates—	.00014 mfd. capacity.....	6.50
11 plates—	.00025 mfd. capacity.....	6.50
17 plates—	.00037 mfd. capacity.....	6.75
23 plates—	.0005 mfd. capacity.....	7.00
17 plates—	extended shaft .00037 mfd. capacity	7.00



Operates from any 110 v. light-socket!

A pleasure to build—and a joy to operate—the Karas 2-Dial Equamatic! The only completely balanced and perfectly neutralized 5-tube A. C. Kit. Uses standard 226 and 227 A. C. Tubes. The A filament supply is furnished by the new and sensational Karas A-C-Former. Build the set that is famous for its distance-getting ability, superb tone volume and amazing selectivity—and then just plug it into any 110-volt A. C. light socket! You can get the complete kit from any dealer or arrange to have it built through your dealer or set builder! The cost is far less than a commercial set of similar quality!

ASSOCIATE MANUFACTURERS

CARTER YAXLEY HAMMARLUND
BENJAMIN SAMSON ELECTRAD DURHAM

Buy or Specify Karas Parts

Karas parts have long been famous for their scientific construction with quality materials! Whether you build yourself, or through your dealer or set builder, be certain to specify Karas parts. You will be pleased and delighted with the extraordinary performance of every part in the Karas line.

Dealers and Set Builders!

Line up with the Karas line! It is accepted by set builders and consumers throughout the country. Karas circuits have met with unqualified success and recommendation, and Karas parts have maintained a high reputation for scientific accuracy and precision! The Karas Transformer line will be unusually complete this year—which is highly important to every dealer!

WRITE FOR CATALOG, FULL INFORMATION, ETC.

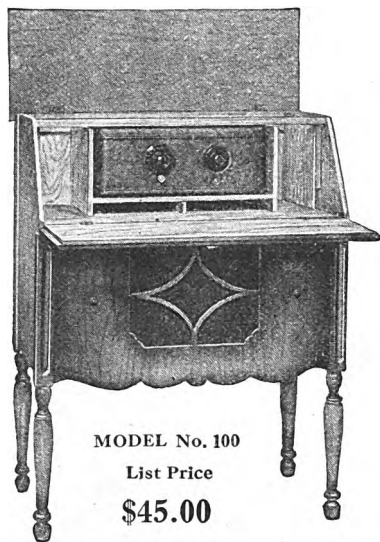
KARAS ELECTRIC CO.

4029 D-N. Rockwell Street, Chicago.

33 years manufacturing precision electrical apparatus!

Corbett Radio Desk

For All Popular Circuits
and Manufactured Receivers



MODEL No. 100

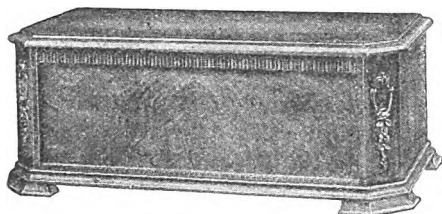
List Price

\$45.00

The Model 100 Desk is a neat and attractive piece of radio furniture which serves a double purpose in the home.

The depth is sufficient to readily adapt it for either manufactured receivers and chassis or the popular circuits like Silver Marshall, Victoreen, Tyrman, HiQ and LC-28.

Offered in select walnut plywood given a high quality shaded finish.



MODEL "C" WALNUT

The ultimate in elaborate and attractive radio cabinets is offered in our model "C." It is an adaptation of the old Italian Chests, being designed and decorated after the spirit of the Renaissance period.

Grooved for 3/16-inch panel with removable top rail. Fancy top stay and piano hinge are applied.

Price List

MODEL "C" CABINETS

Walnut Only

Panel Size	10 in. deep	12 in. deep	Weight	Mounting Boards
7x18	\$15.50	\$17.00	26	\$.90
7x21	17.00	18.50	28	1.00
7x24	19.00	20.50	31	1.10
7x26	20.50	22.00	34	1.20
7x28		23.00	37	1.30
7x30		24.00	40	1.40

Corbett cabinets are in stock ready for shipment.

Write for illustrated folders showing complete line of radio consoles and cabinets.

Corbett

Cabinet Manufacturing Co.

St. Marys, Pa.

In the Professional Set Builder's Shop

(Continued from page 318)

A New Power Valve

A STILL larger and more powerful amplifier valve has recently been announced by valve manufacturers. It is designated as the 250 power amplifier and is capable of delivering over three times as much undistorted energy as the UX-210, long the favorite power amplifier valve for maximum volume and tone quality in home reception.

The 250 is considerably larger in size than the 210, although its base is identical. The filament of the new power amplifier is of the improved coated ribbon type, which insures great mechanical strength and operating life.

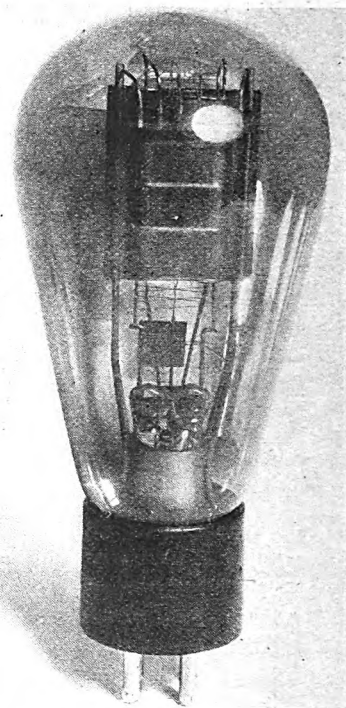
This new valve will provide a far greater output volume, without distortion, than has heretofore been possible, especially in conjunction with auditorium reproducers and in the operation of a number of reproducers from a common amplifier, as in hospital and exposition work. It is interesting to note that while the plate voltage has not been materially increased over that of the 210, the required plate current is three times as great as for the 210.

The characteristics of the 250 are given in the accompanying chart.

When used as a transmitting valve the UX-250 is rated at 25 watts as against the 7½-watt rating of the 210. As a power amplifier (receiving) valve the maximum undistorted output of the 250 is 4,650 milliwatts (4.65 watts) as against 1,540 milliwatts (1.54 watts) for the 210, 700 milliwatts for the 171, 195 milliwatts for the 112-A, and 110 milliwatts for the 120 power valve.

As with other large power amplifier valves, the output of the 250 cannot be led directly to the ordinary reproducer. Instead, it is necessary to utilize some form of reproducer coupling system, either in the form of an output transformer or a choke and by-pass filter.

With the addition of the 250, it now appears that every conceivable radio requirement is filled, from the small dry-battery operated receiver to the large auditorium amplifier that entertains large audiences with the radio.



THE 250 POWER VALVE

Occasional Testing Keeps Valves Fit

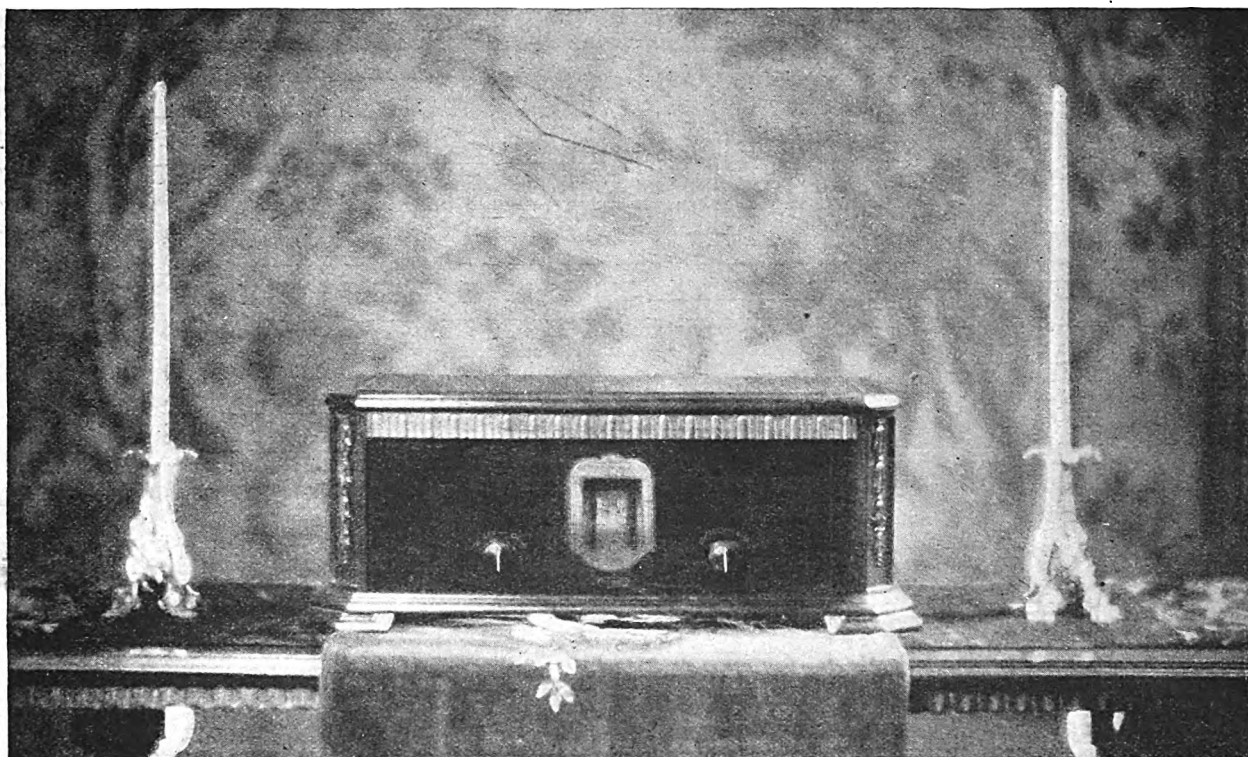
It is a good plan to have the valves in a receiver tested after every three or four hundred hours of service. If a receiver is in use an average of three hours per day, for instance, it will be worth while to have a service man test the valves about once every four months, and to replace any that are found to be wearing out. This is particularly important where the receiver makes use of rheostats for the adjustment of the valve filament supply, because if a single valve starts to wear out there will be a tendency to make up the decreasing volume by turning the other filaments up higher, and the usual result is that several valves are prematurely worn out, whereas replacement of the one poor valve would have saved the others.

—OGDEN ALBERSON

CHARACTERISTICS OF THE 250 POWER VALVE

	Recommended		Maximum	
Plate voltage (volts).....	250	300 350	400	450
Negative Grid Bias (volts).....	45	54 63	70	84
Plate Current (millamperes).....	28	35 45	55	55
Plate Resistance (a-c) (ohms).....	2100	2000 1900	1800	1800
Mutual Conductance (micromhos)....	1800	1900 2000	2100	2100
Voltage Amplification Factor.....	3.8	3.8 3.8	3.8	3.8
Max. Undistorted Output (milliwatts).	900	1500 2350	3250	4650

Filament	7.5 Volts	1.25 Amperes
Max. Overall Size.....	Height 6¼"	Diameter 2 11/16"
Base	Standard UX	



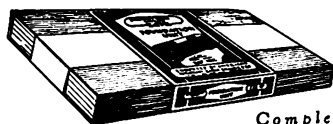
The New Improved Hi-Q Six—the creation of ten foremost American Radio Engineers—a receiving instrument that is far in advance of its time.

Exclusively CUSTOM-BUILT By Yourself at Home . . . from our Simple Instructions . . . and at Great Savings!

No ordinary standards can be applied to this latest improved Hammarlund-Roberts Receiver, for it is the result of a determination to produce America's very finest instrument—absolutely regardless of cost! Every modern constructional feature has been incorporated. Each part is the most efficient known to radio science, and the entire group has been purposely selected for perfect synchronization. Complete isolation of four tuned circuits plus Automatic Variable Coupling effects maximum and uniform amplification over the entire wave band. Distortion is totally eliminated. Oscillation is utterly absent. Symphonic transformers and a power tube

faithfully reproduce the full musical scale. Selectivity, even in crowded areas, is something to marvel at. And tonal quality simply MUST be heard to be appreciated!

Such a set, factory made, and sold through usual channels, would possibly cost around \$300.00, but, through following our simple instructions, you can purchase all parts for only \$95.80 and build this supreme receiver yourself—a CUSTOM BUILT set which gives you CUSTOM BUILT results at a saving of \$100 to \$150. Get the complete Hi-Q Instruction Book from your dealer—or write us direct. Price 25 cents.



Completely drilled panel and sub-panel are foundation for easy building.

Hammarlund ROBERTS Hi-Q SIX

HAMMARLUND-ROBERTS INC.

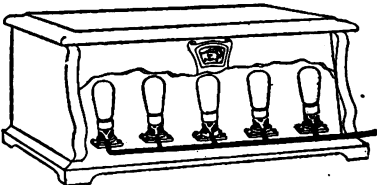
1182 Broadway, Dept. B

New York City

Associate Manufacturers



CORWICO
A-C ADAPTOR HARNESS



EASIEST and QUICKEST WAY to A-C Tube Operation

No re-wiring. The Corwico A-C Harness takes care of that. Can be used to convert all makes of receivers. Only universal A-C Harness made.

Connect Corwico harness to any standard step-down transformer. Insert the A-C tubes into the adaptors and any battery set of six tubes or less is changed into an A-C Receiver.

Made for ALL Types A-C Tubes

One with adaptors attached for R. C. A. and other A-C type tubes and one without adaptors for Arcturus A-C cable tubes.

Type "R" for R. C. A. Tubes	Type "A" for Arcturus Tubes
\$8.50	\$6.00

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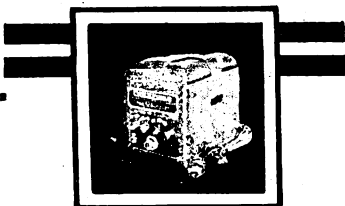
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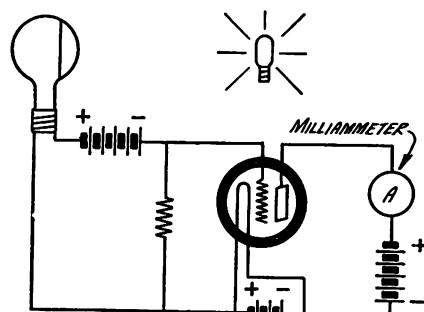
The "Eye" of Television

(Continued from page 300)

proportional to the intensity of the light falling upon it. However, this statement requires a little modification. It is true, provided the color of the light is not changed, but it is not true that equal intensities of blue and red light will produce the same response in the cell.

In this respect the cell resembles the human eye, in that it is not equally sensitive to all colors. Figure 4 shows the visual sensitivity curve of the average human eye. The ordinates represent the relative effect produced on the eye by equal amounts of light energy of different colors. The maximum occurs in the yellow-green portion of the spectrum for the average person. Of course, for a color-blind person the curve would be different. Now, if we investigate a photo-electric cell of, let us say, potassium in the same fashion, by exposing the cell to equal amounts of energy of light in different parts of the spectrum and observe the current which passes through the cell we will obtain the curve shown in Figure 5. This curve, like the visual sensitivity curve, passes through a maximum, but the maximum for potassium occurs near the ultra-violet part of the spectrum and the curve is very low in the red part of the spectrum. This means that a potassium cell does not see colors the same way that we do, as it is far more sensitive to blue and less sensitive to red light. The shape of this curve and the wavelength for maximum sensitivity differs for different substances. No two elements see colors in just the same way.

One application in which color sensitivity plays a very important rôle is in the photometry of lamps. Instead of measuring the candlepower of lamps by means of a visual photometer, a number of methods have been devised for doing the same thing with photo-electric cells. Now suppose that two lamps, one gas-filled and one a vacuum-type lamp, have been compared with a visual photometer and found to be of the same candlepower. If these two lamps are now compared on a photo-electric cell photometer, the results will not agree with the visual measurements. The gas-filled lamp operates at a higher temperature than the vacuum lamp and so emits a larger proportion of its radiation in the blue portion of the spectrum. The photo-cell is particularly sensitive to blue radiation and will give a larger current for a given amount of blue than for the same amount of red light. Consequently, to the cell, the gas-filled lamp will appear the brighter, although to the eye both lamps appear the same. This defect is overcome by correcting the cells by means of suit-



AMPLIFYING THE OUTPUT OF A CELL

FIGURE 6: This diagram shows how the output of a cell may be amplified by means of a stage of resistance-coupled amplification somewhat similar to those employed in many present-day receivers.

able color filters before the cell window.

In cases where it is desired to use ultra-violet instead of visible light, the cell are made somewhat differently. Instead of the alkali metals, substances such as zinc, magnesium and cadmium are used. These metals are sensitive to ultra-violet light, but not to visible light. Ordinary glass is nearly opaque to ultra-violet, so the bulbs are made of quartz.

The output current of the photo-electric cell is small, so that for most practical applications it must be amplified. This can be done with ease by using vacuum valve amplifiers in circuits well known to all radio men. One of the simplest of these circuits is shown in Figure 6. A grid-leak resistance of several megohms is connected in series with the photo-electric cell and the ends of the resistance are connected to the amplifier valve filament and grid, respectively. Any changes in cell current produce similar changes in the potential drop across the resistance, which results in large changes in current in the plate circuit of the radio valve. Of course, this is nothing but resistance-coupled amplification.

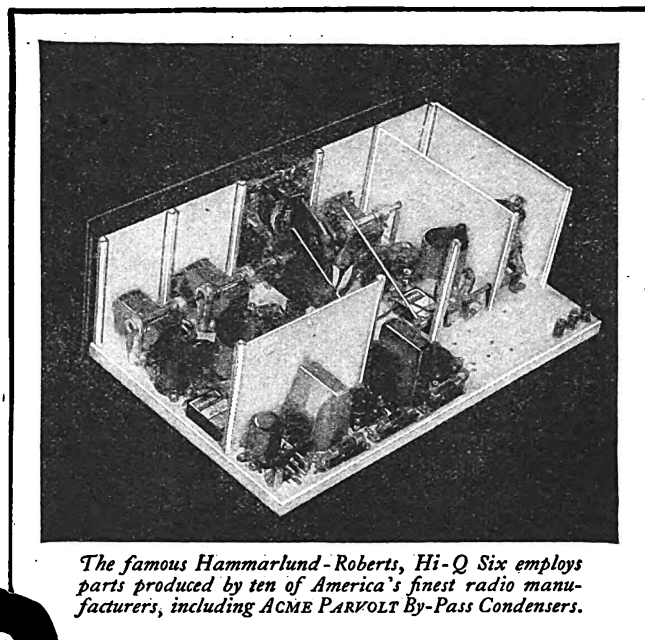
Now as to possible uses of the photo-electric cell. New applications for it are arising every day. Two of the most spectacular ones are television and the talking movies. There are a number of systems of television, all of them fairly complicated, but the essential feature in all of them is the photo-electric cell. A beam of light travels across the object to be viewed and is then reflected back into a photo-electric cell. The amount of light falling upon the cell will depend upon the object, the white parts sending a strong beam of light into the cell and the dark parts a weaker beam. These will produce respectively large and small currents in the cell. Thus the shading of the object is translated into an electric current of varying magnitude.

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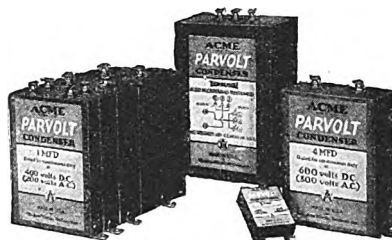
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Popular Radio

EDITED by RAYMOND FRANCIS YATES



FOUNDED 1911

VOLUME XIII

May, 1928.

NUMBER 5

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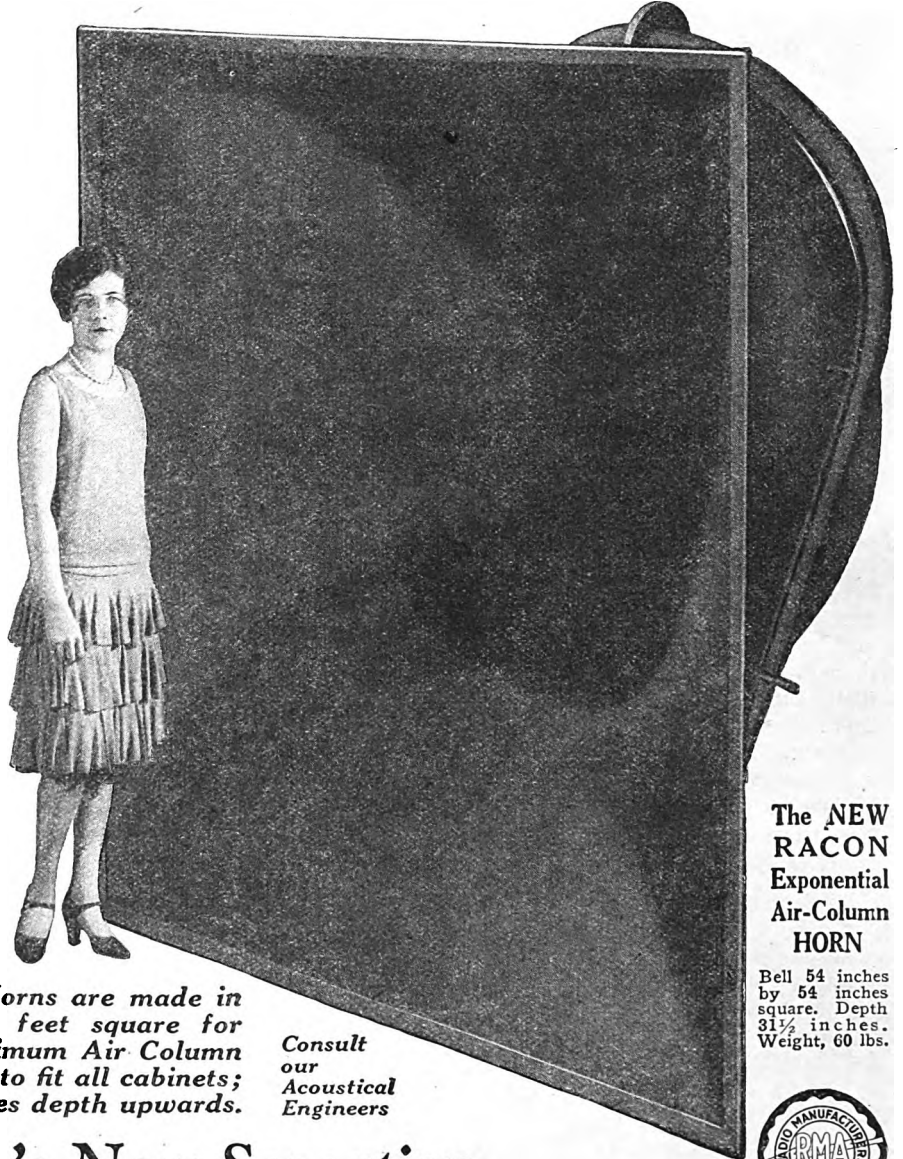
INTERNATIONALLY known Acoustical Engineers have pronounced Racon Exponential Air-Column Horns the finest made and an advance step in the History of Acoustics;—a tribute to the engineering exactness with which they are designed and manufactured.

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RACON ELECTRIC CO. INC.

A PAGE WITH THE EDITOR



*A Photograph of Governor Alfred Smith, of New York,
Received by Radio on Rayfoto Apparatus*

SEVERAL weeks ago the Editor experienced the indescribable thrill of tuning in a moving picture from the emptiness of space. Out of an incoherent and jumbled mass of flashes in a mirror there appeared, as though by magic, the picture of a little girl jumping rope. The impressions of this little girl were on a motion picture film at a broadcasting station eight miles away. An ordinary radio receiver was used and the manipulation of the tuning control either destroyed or created the picture.

* *

NOT MANY living men have tuned "movies" in from the air, but it will not be very long before hundreds of thousands of people are daily experiencing this thrill.

* *

It is rumored that certain of the larger manufacturers of receivers will show for the first time at the Chicago Trade Show, in June, a television receiver for home use. The art is moving fast. Nobody dreamed of that a year ago. Tomorrow it will be commonplace.

IN THIS issue of POPULAR RADIO AND TELEVISION the Editors have made an attempt to supply information on television, so that the home experimenter can proceed with this fascinating work. Next month, the actual details and constants of the circuits employed will be given.

* *

TELEPHOTOGRAPHY is a step toward television. Three days each week WOR, in Newark, N. J., broadcasts photographs which may be received on the Rayfoto machine. Richard Lord, an old contributor to POPULAR RADIO AND TELEVISION, begins a description of the apparatus in this issue, on page 370. Next month Mr. Lord will give the constructional and circuit details of the Rayfoto apparatus.

* *

IN THIS issue POPULAR RADIO AND TELEVISION introduces to its readers for the first time the constructional details of the Tyrman "70." In laboratory tests, the Tyrman has demonstrated a performance that is a real credit to radio engineering.

IT HAS been the object of the Editor to make the new department, THE PROFESSIONAL SET-BUILDER'S SHOP, more and more useful to those readers who make their livelihood in the construction of custom-built receivers. This department is filled with good things this month, and the editorial sanctum sends out an appeal to all professional set-builders who would like to help their fellow craftsmen by sending in small contributions.

* *

IN THIS issue the department, IN THE WORLD'S LABORATORIES, is resumed. New discoveries announced in this department will be related to radio science, and not to general science, as was the practice in the past.

* *

DURING the past several months the POPULAR RADIO Laboratory has become interested in crystal detection, and the LC-28 Junior, described in this issue on page 378 embodies a modern crystal unit of the permanently adjusted type. Due to the perfect detection afforded by this unit, the LC-28 Junior is admirably suited to local, high-quality reception. Today there are hundreds of thousands of people who have gotten over the "distance" fever, and who demand, in the way of a radio receiver, simplicity, high-quality, and ease in manipulation. The LC-28 Junior will meet every one of these demands.

* *

BY WIRE and letter from all parts of the country there is daily arriving at POPULAR RADIO AND TELEVISION congratulations on its foresight in entering the field of television. It is the first radio publication in the country to officially announce its devotion to this new science. Henceforth this magazine will be an important factor in developments that are to come in "seeing by radio."

* *

SOME day, in the yet distant future, the readers of POPULAR RADIO AND TELEVISION may have the opportunity of peeking into the POPULAR RADIO AND TELEVISION laboratory while sitting in their easy chairs at home. All of which reminds us of a pun from a recent visitor to the office, who said: "People who live in television houses should never throw parties."

Raymond F. Yates



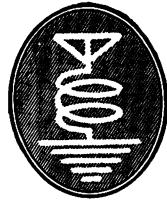
Foresight and Courage . . .

"It seems to me that the primary functions of a radio magazine are to unearth new and effective developments and to present them to its readers in a thoroughly comprehensive manner. Given such a background the manufacturer who prepares the necessary essentials to supply the demand thus created is enabled better to serve those readers who desire to take advantage of such opportunities. POPULAR RADIO is to be congratulated on its foresight in discerning this business fundamental, and on its courage in following this conviction."

Arthur H. Lynch

PRESIDENT,
ARTHUR H. LYNCH, INCORPORATED.

Popular Radio



VOLUME XIII

May, 1928

NUMBER 5

Experimenting With TELEVISION

Here is POPULAR RADIO's first direct contribution to the advancing art of "seeing by radio." The following article outlines the Technical Staff's experiments with the use of the fundamental components of modern television systems—scanning disc, photo-electric cell, and neon lamp. These experiments have been purposely made with apparatus that is within the reach of the fan of modest means, so that all those interested in the advance of television may follow the course of our investigation, from month to month, with apparatus similar to that used in the Laboratory. .

By ROBERT W. TAIT

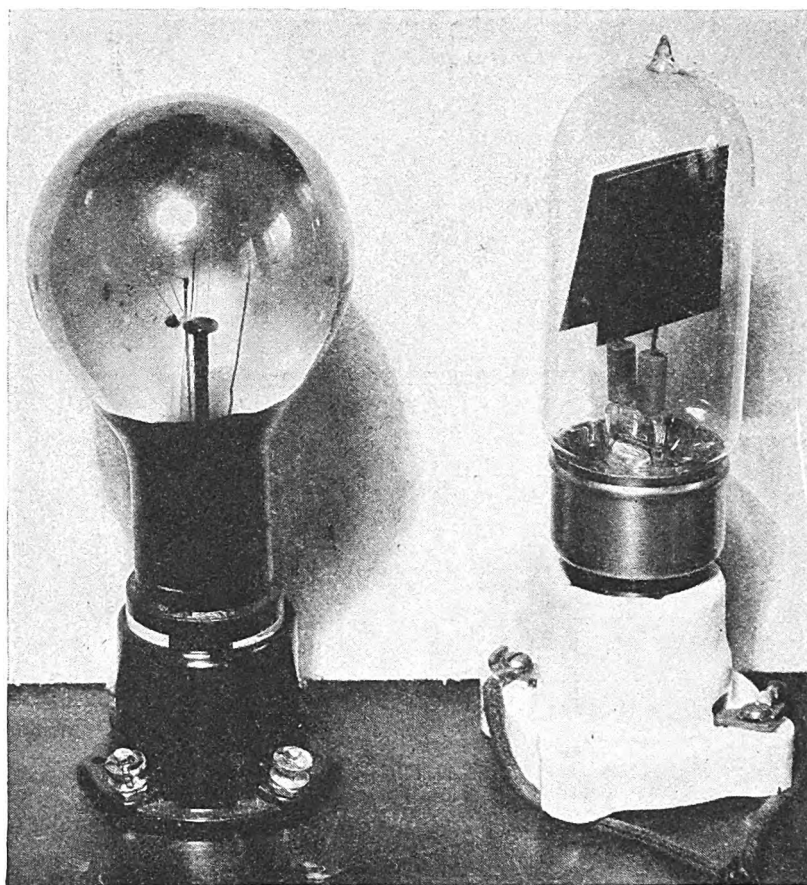
TELEVISION reception and even television transmission has at last been reduced to the stage of simplicity and practicability, where it becomes available for home experimentation. The apparatus involved in these experiments is not expensive, nor does its manipulation require anything more than an empirical knowledge of radio. Any alert experimenter and radio fan who has had the experience of assembling radio receivers and who understands, even superficially, the principal laws of radio and electricity, may plunge into the construction of television apparatus with every assurance of some measure of success.

The equipment about to be described was recently assembled in the POPULAR RADIO Laboratory and, while this article is more in the nature of a report on the results, an article which will appear in a subsequent number which will give full details and constructional data.

The experimental equipment involved comprises not only a television receiver but a simple transmitter as well, the television transmitter being connected to the receiver by wire.

The equipment about to be described is, in a sense, not really a television transmitter. For actual television an extremely powerful source of light is necessary and large and expensive photo-electric cells must be used to intercept the scanning beams. Naturally, this large and expensive equipment is quite beyond the pocketbook of the average experimenter. Consequently, the POPULAR RADIO Laboratory decided to confine its efforts to modest equipment that could easily be purchased and that would be inexpensive. This plan made it necessary to be satisfied with the transmission of ordinary photographic negatives and little black and white cartoons, drawn on celluloid or glass in simple outlines.

A television transmitter of the type about to be described involves three principal components: the source of light, the scanning disc, and the photo-electric cell. The source of light, in the case of the experiments under discussion, was simply a 500-watt lamp mounted in an aluminum shield or can and provided with proper ventilation. In the front of the can an aperture was cut which was the size of the picture to be projected over the apparatus. This arrangement will be clear by referring to Figure 3, which shows the laboratory set-up. If the experimenter has a small motion picture arc lamp available, it would be advisable to use this source of light; for it must be remembered that the more powerful the source of light the more pronounced the fluctuations at the receiving end will be. Consequently the picture will be clearer. During normal operation this source of light is moved as close to



THE TWO EYES OF TELEVISION

FIGURE 1: The photo-electric cell at the left and the neon lamp at the right were used in the Laboratory experiments in television. The photo-electric cell was painted dull black, except on the clear glass window, to eliminate the danger of distortion due to reflected light.

the scanning disc as possible so that there will be no waste of light energy. Naturally, the position of the light source and the aperture must coincide with the holes in the scanning disc, so that successive holes will move across the light source in the proper sequence.

On the opposite side of the disc a small frame, with an aperture measuring $1\frac{1}{2}$ inches by $1\frac{1}{2}$ inches, was placed. In this frame the picture was mounted. Back of the picture there was placed a photo-electric cell of the vacuum type. The cell was in a small metal or cardboard box, painted a dull black inside to eliminate the danger of reflection. An aperture was cut in the box so as to accommodate the frame holding the picture.

The photo-electric cell was connected to a four-stage, resistance-coupled amplifier, properly biased. To the output of this resistance-coupled amplifier a neon lamp was attached. Modulation of the cell was brought about in the manner shown in Figure 4. The voltage of the "B" eliminator was adjusted to a point somewhere near the critical voltage of the neon lamp, and the biasing of the resistance-coupled amplifier

was adjusted so that when the light fell upon the photo-electric cell the neon lamp would function.

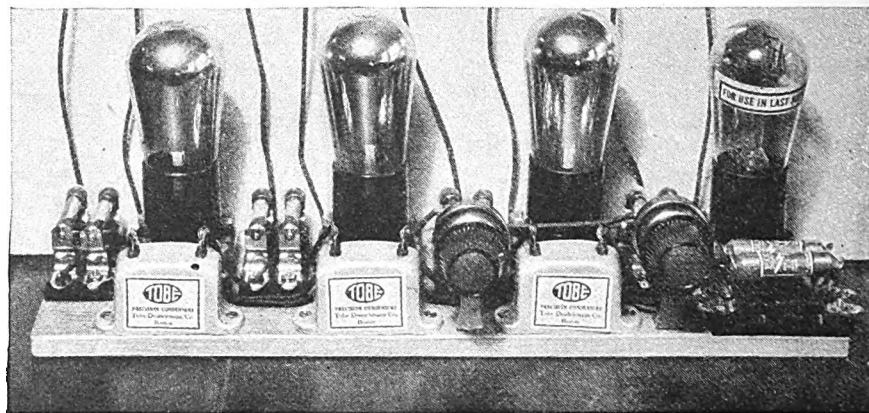
To facilitate research and to avoid the necessity, for the time being, of using two independent motors, only one scanning disc was employed and transmission was made on one side of the disc and reception on the opposite side.

This entirely solved the problem of synchronization, for it is obvious that the apparatus was perfectly synchronized. Subsequent experiments, however, proved that the transmitter and receiver could be widely separated by employing two scanning discs and two ordinary $\frac{1}{4}$ -horse-power synchronous motors. A subsequent article in the June issue will outline the details of this arrangement. With the present apparatus it was possible to see, at the receiving side of the disc, a crude outline of the picture in the frame at the transmitting side. The neon lamp, which takes the place of a loudspeaker, and which might be called a "light loudspeaker," was placed back of the scanning disc so that it could be viewed through the holes that were arranged in the spiral. A small cardboard frame was cut to dimensions corresponding to the aperture in the transmitting frame. This cardboard frame was then mounted before the scanning disc in exact line with the neon lamp so that it too could be scanned with holes in the spiral.

The scanning disc used was made of aluminum, 23 inches in diameter and provided with 48 holes .033 inches in diameter. This corresponds to a No. 61 drill. The spiral was off-set $1\frac{1}{2}$ inches and the holes were placed $1\frac{1}{2}$ inches apart, corresponding to a picture sized $1\frac{1}{2}$ by $1\frac{1}{2}$ inches.

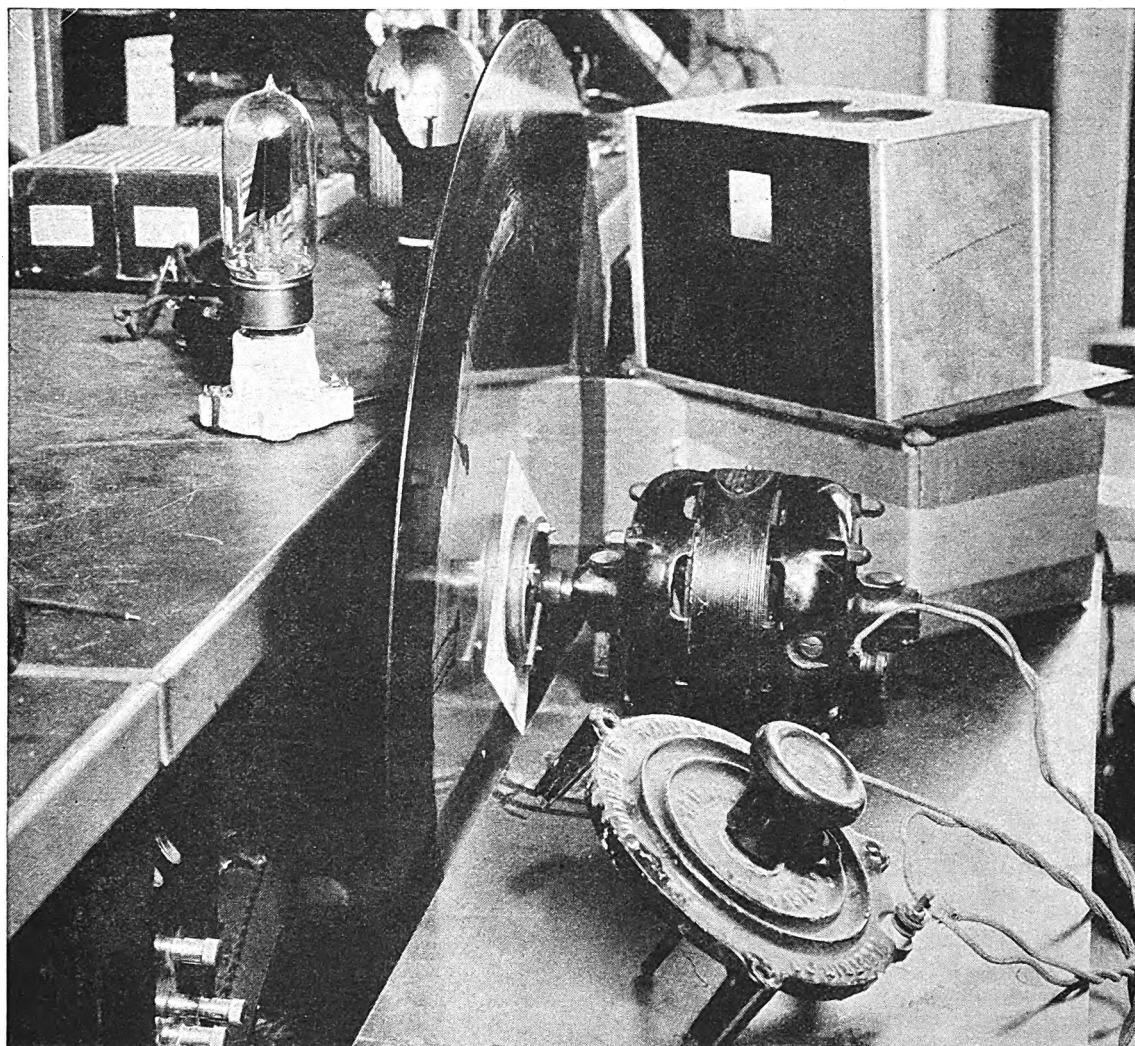
The method of laying out the spiral will be made clear by reference to the article on this subject which appears in this number on page 390. The aluminum disc, owing to its highly polished surface, was painted with an egg shell black preparation, care being taken to see that the preparation did not fill up any of the holes in the disc.

In these experiments, the motor speed was by no means critical and, to avoid mechanical difficulties involved in high



THE AMPLIFIER FOR THE TELEVISION RECEIVER

FIGURE 2: The above resistance-coupled low-frequency amplifier was constructed especially for the television experiments. It employs standard parts in an easily assembled layout. Its construction will be described in the June number of this magazine.



THE APPARATUS USED IN THE EXPERIMENTS

FIGURE 3: At the left are the photo-electric cell and the neon lamp. The scanning disc, with its driving motor and resistor for controlling the motor speed, are in the center. At the right is the light source, in this case a 500-watt lamp mounted in a standard aluminum box shield with a small window in front and ventilating holes in the top. Egg shell black paint was applied to all the surfaces which might cause distortion from reflected light.

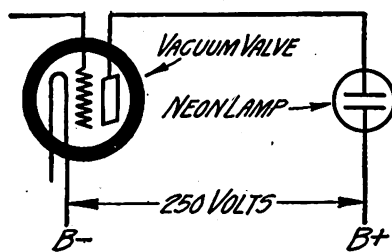
speed, which would have made the mounting of the disc on the shaft somewhat of a problem, the resistance was placed in series with the motor to cut it down to low speed. To those who have gone into the subject of television, it is obvious that the picture, whether still or moving, must be transmitted at the rate of sixteen times per second; that is, the scanning disc must scan the picture sixteen times every second, which means a minimum R. P. M. of 960. Due to visual persistency, the eye insists on seeing an impression for at least 1/16th of a second, and any speed below this produces unsatisfactory results. However, in the experiments mentioned, it was found possible to cut down the speed as low as twelve per second and to still preserve the illusion.

When the outfit described above is used in the transmission of pictures, the room must be darkened. Otherwise

the photo-electric cell will respond to extraneous light and the picture illusion which appears in front of the neon lamp will be considerably weakened.

A resistance-coupled amplifier was chosen for these experiments owing to its aperiodic reproducing qualities. When simple silhouettes are to be transmitted, it is perfectly feasible to use an

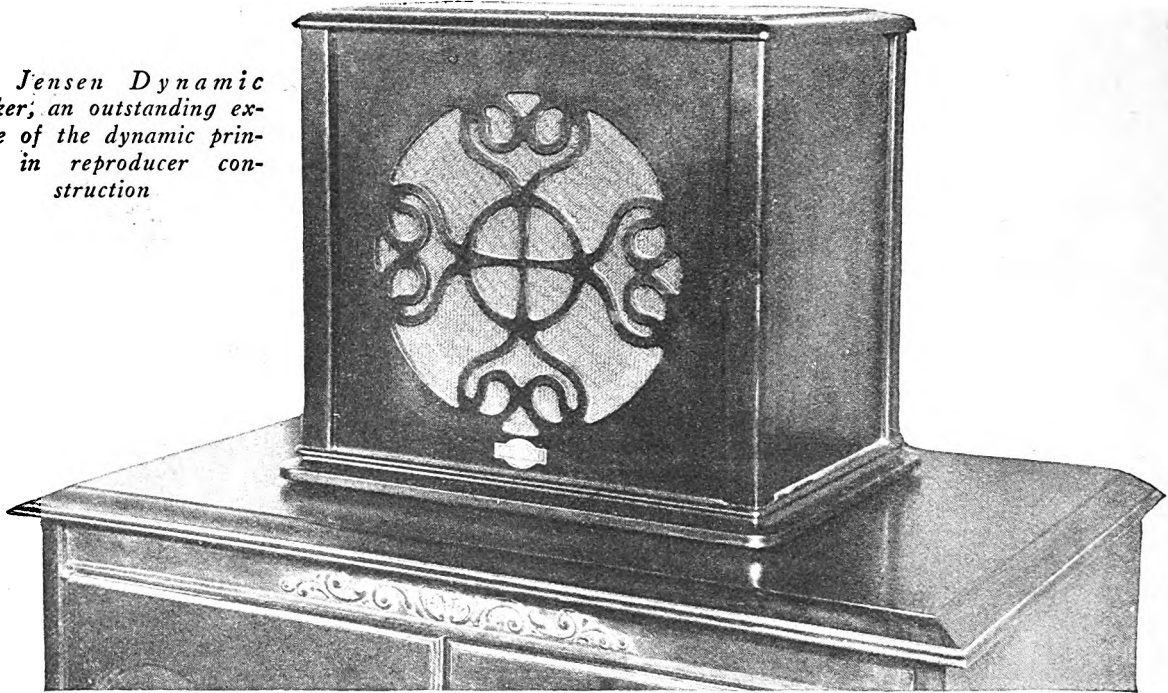
ordinary transformer or impedance-coupled amplifier, for the frequencies involved are well below the critical point of this type of transformer-coupled amplification. The average low-frequency transformer will not respond to impulses over 10,000 cycles, and if a complicated picture is being transmitted (that is, a picture that breaks the light beam up a large number of times per second); the frequencies involved may well become high enough to go beyond that point where a low-frequency transformer will not pass them without distortion. In resistance-coupling this problem is entirely obviated, and if the experimenter plans to go into television, it will be wise for him provide himself with the proper kind of resistance-coupled amplification. The details of the particular amplifier used in these experiments will be described in the June issue of POPULAR RADIO.



THE NEON LAMP CIRCUIT

FIGURE 4: This detail diagram shows the circuit connections between the last stage of the resistance-coupled amplifier, shown in Figure 2, and the neon lamp.

The Jensen Dynamic Speaker; an outstanding example of the dynamic principle in reproducer construction



DYNAMIC SPEAKERS

How They Work

By HENRY GIBSON

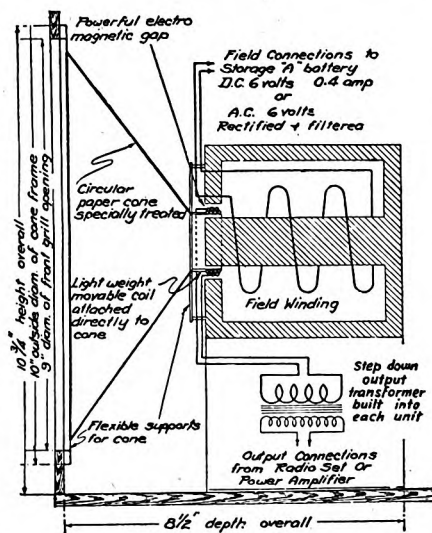
HIGH power loudspeakers may be roughly divided into two distinct classes, the direct drive and the moving coil drive. In the direct drive type, the driving rod is attached both to the armature of the speaker and to the cone or diaphragm. Impulses imparted to the armature are conducted to the cone or diaphragm through the medium of a small coil attached to the apex of the cone member.

The Jensen "Dynamic" speaker (a term applied to all moving coil speakers) is a fine embodiment of the dynamic principle. The constructional details of this speaker are exceptionally well executed and many subtle refinements have been incorporated which give it an especially flat reproduction curve. In Figure 1 the reader will find the general layout of these essential components. The cone, which is of a special grade of paper, measures 8 inches in diameter, with a depth of approximately $3\frac{1}{4}$ inches. Through the medium of soft leather, the cone is permitted to float in a cast-metal frame, its small end being held in the proper position with a light aluminum member which keeps the coil in concentric position in relation to the core of the exciting coil. The driving coil proper is affixed to the apex of the cone, being wound on a small fibre tube.

Those who understand the operation of electrical measuring instruments are familiar with the D'Arsonval principle which, in a nutshell, might be stated as the tendency of a coil to move when subject to a fluctuating magnetic field. In electro-dynamic speakers, there is response of the coil to the magnetic field

that provides the actual driving force. The output from a radio receiver is permitted to flow through the small coil mounted at the apex of the cone, while a steady and unvarying magnetic field is constantly maintained by a powerful electro-magnet. The interaction of the two fields, one constant and one varying, provides the mechanical motion.

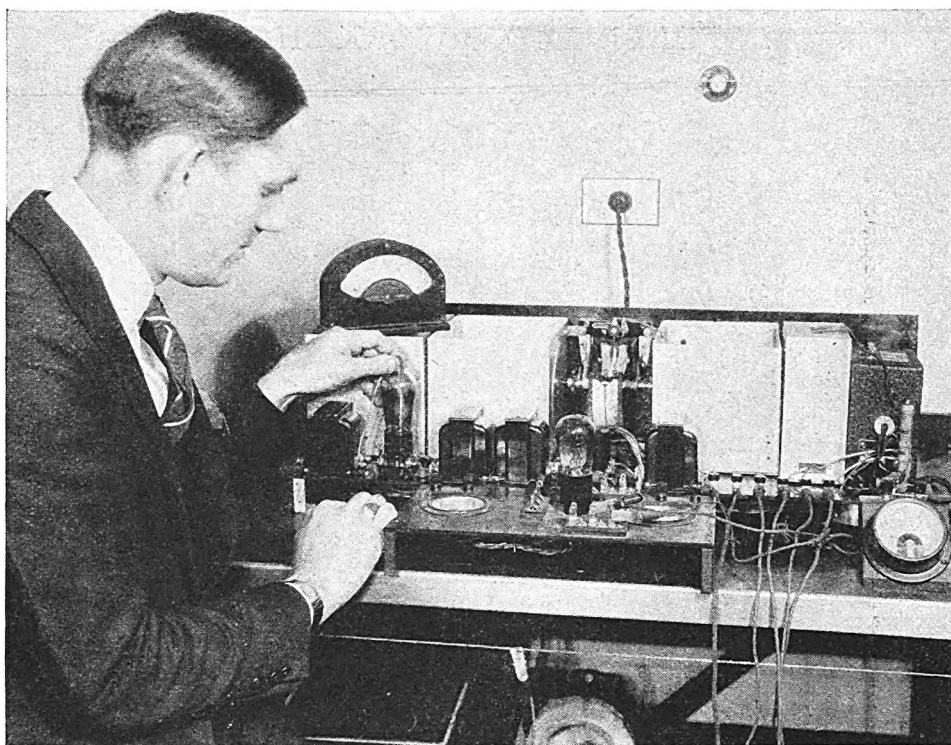
The field coil of the Jensen type D44 speaker is excited from either a 6- or 12-volt source, which may be a storage battery or an "A" battery eliminator. The AC type D45 obtains its field coil supply from the power amplifier circuit, the coil acting as a choke. With a field resistance of 2,250 ohms, the energizing current of the field coil is somewhere between 30 and 40 milliamperes at a voltage between 80 and 90. The resistance of the magnetizing coil of the DC or D44 type is 15 ohms and the current consumption is in the neighborhood of .4 amperes at 6 volts. All types of Jensen speakers are provided with a step-down output transformer having a ratio of 25 to 1, into which the power amplifier feeds. This step-down or output transformer is really an impedance balancer, since it is obvious to experimenters that the low resistance moving coil, which is comprised of only a few turns, could not possibly be con-



HOW THE SPEAKER WORKS

FIGURE 1: The heavy field magnet is excited by an outside source. The output of the amplifier is fed through the step-down transformer to the light moving coil attached to the cone.

(Continued on page 423)



CHECKING UP THE CHARACTERISTICS

The engineer is testing the low-frequency circuits of the QSA-5 receiver. This part of the receiver is of new circuit design, has been very carefully tested in the POPULAR RADIO Laboratory.

Building *the* QSA-5

The construction and operation of the QSA-5 screen grid receiver is given in complete detail in this article. The constructor will find this new receiver, with its unusual features in circuit design and construction, a set of extraordinary quality and range.

By LAURENCE M. COCKADAY

THE outstanding features of the QSA-5 receiver were described in detail in the April number of POPULAR RADIO, and the reader is referred to the article on page 293 of that issue for a thorough theoretical consideration of the circuit. Briefly, the receiver consists of two stages of high-frequency amplification employing screen grid valves, a vacuum valve detector, a two-stage low-frequency amplifier, and a self-contained "B" voltage supply. The first stage of low-frequency employs a screen grid valve, coupled to the detector through a transformer, and the screen grid valve stage is coupled to the final 171 power valve stage through an impedance coupling of new design. The schematic diagram of the circuit is shown in Figure 4.

Assembling the QSA-5

While at first glance the QSA-5 may seem a little complicated, yet by a

steady progressive system of construction this set can be assembled and wired comparatively quickly. The first instruments to mount are the three Benjamin brackets, T1, T2 and T3, as shown in the diagram in Figure 5. Then the panel may be turned over and the assembling of the instruments located on the top of the panel is now ready to commence. Mount the Aero coils A1, A2 and A3 on the bases of the aluminum cans, C1, C2 and C3. Likewise locate and fasten in position the Benjamin sockets, L1, L2 and L3, followed by the Hammarlund high-frequency chokes, E1 and E2, in cans C2 and C3, respectively.

The Aerovox grid condenser, N4, and the Aerovox by-pass condenser, N3, should then be fastened to the Benjamin socket, L3. The Aerovox moulded condenser, N2, should similarly be placed and fastened to coil A3 and choke coil E2. The Aerovox wire wound

resistances, M1 and M2, should then be fastened to their respective sockets and to the aluminum base at the free end. These three bases of the shields, C1, C2 and C3, with the various instruments before mentioned, should now be placed upon the Westinghouse Micarta sub-panel, together with the Thordarson power compact, I, and the Aerovox condenser "B" block, J, and fastened securely in position as shown in Figure 1. The Yaxley Junior 10-ohm rheostats, R1 and R2, which are centrally located on the sub-panel should now be secured firmly in position. The Thordarson transformer unit, F, the autoformers, G1 and G2, and the output transformer, H, should now be fastened down securely by means of screws. Benjamin sockets L4, L5 and L6 may now be placed and fastened. The Centralab 5,000-ohm potentiometer, R5, and the XL binding posts, U1 to U6, may readily be located and

POPULAR RADIO WORK SHEET

THE QSA-5 RECEIVER

LIST OF PARTS USED IN
BUILDING THIS RECEIVER
COST OF PARTS—Not over \$139

A1—Aero antenna coil, type No. 96;
A2 and A3—Aero universal coils, type No. 43, equipped with two special Aero primary coils, type No. 111;
A4—Special home made plate coil;
B1 to B3—Hammarlund midline variable condensers, .0005 mfd.;
C1 to C3—Hammarlund stage shields;
D—Hammarlund double-drum dial;
E1 and E2—Hammarlund high-frequency chokes, type No. 85;
F—Thordarson low-frequency transformer, type R-200;
G1 and G2—Thordarson Autoformers, type R-190;
H—Thordarson Speaker coupling transformer, type R-76;
I—Thordarson power compact, type R-171;
J—Aerovox filter condenser block, type TH-862;
K1 and K2—XL vario-condensers, type G-1;
L1 to L6—Benjamin Cle-ra-tone sockets, No. 9040;
M1 to M3—Aerovox wire wound resistances, 10 ohms, type No. 980;
N1 and N2—Aerovox moulded condensers, .00025 mfd.;
N3—Aerovox moulded condenser, .001 mfd.;

N4—Aerovox moulded condenser, .00025 mfd., with clips for gridleak mounting;
O—Durham metallized resistor, 1 megohm;
P1 to P3—Control grid connectors;
Q1—Aerovox Pyrohm resistance, with two extra taps, 10,000 ohms, type 994 QSA;
Q2—Aerovox Pyrohm resistance, 2000 ohms, type No. 992;
R1 and R2—Yaxley Junior rheostats, 10 ohms, type 510;
R3—Yaxley Junior rheostat, 3 ohms, type 503;
R4—Claroostat volume control;
R5—Centralab heavy-duty potentiometer, 5000 ohms;

S—Aerovox filter condenser, .25 mfd., type 200;
T1 to T3—Benjamin brackets, type No. 8629;
U1 to U6—XL push-posts with new bakelite top;
V—Carter automatic power switch, type No. 115;
W—Westinghouse micarta panel, 9 by 30 by 3/16th inch;
X—Westinghouse micarta sub-panel, 10 by 30 by 3/16th inch;
Y—Hammarlund insulated flexible coupling;
Z—Hammarlund brass extension shaft, 7 1/2 inches long and 1/4 inch in diameter;
Gavitt hook-up wire, brackets, etc.

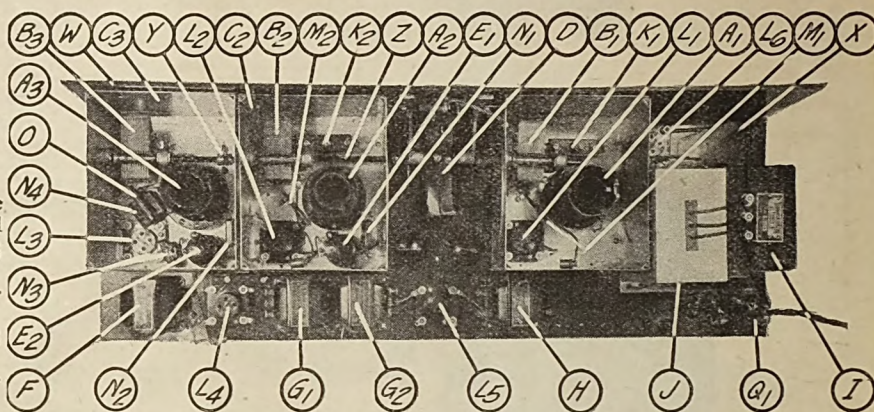
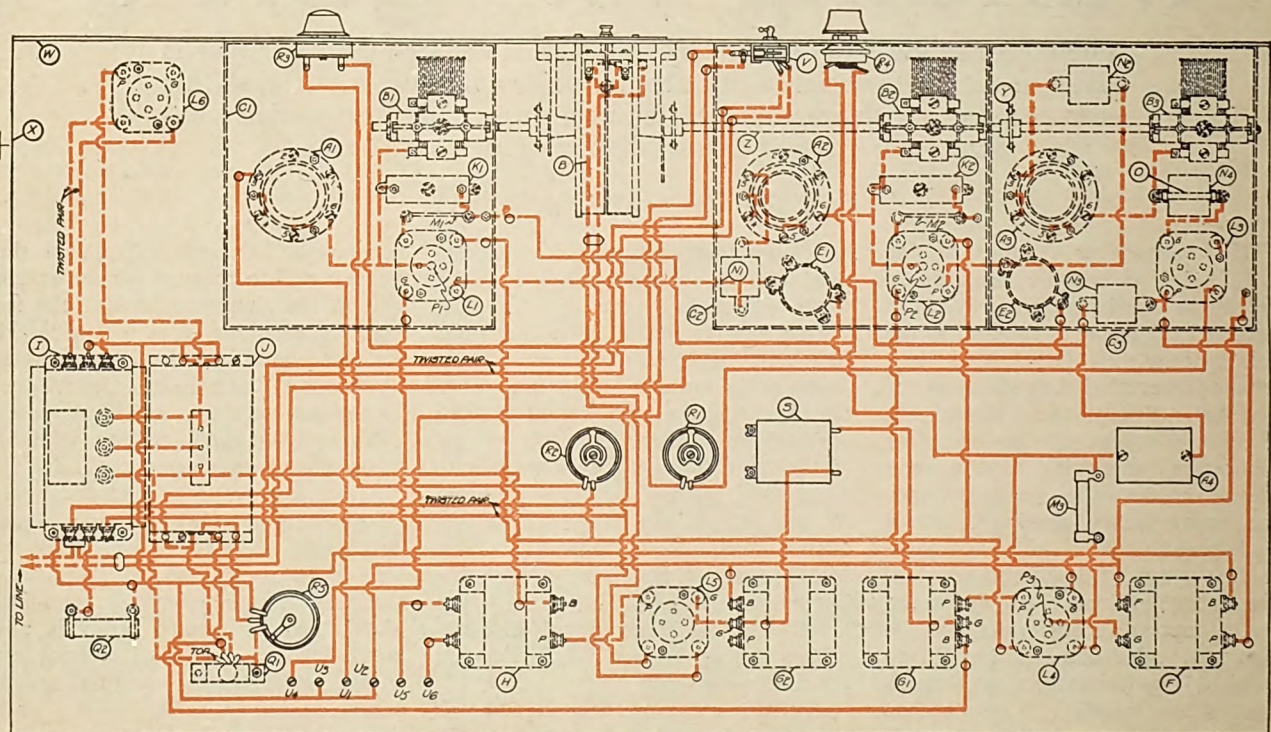
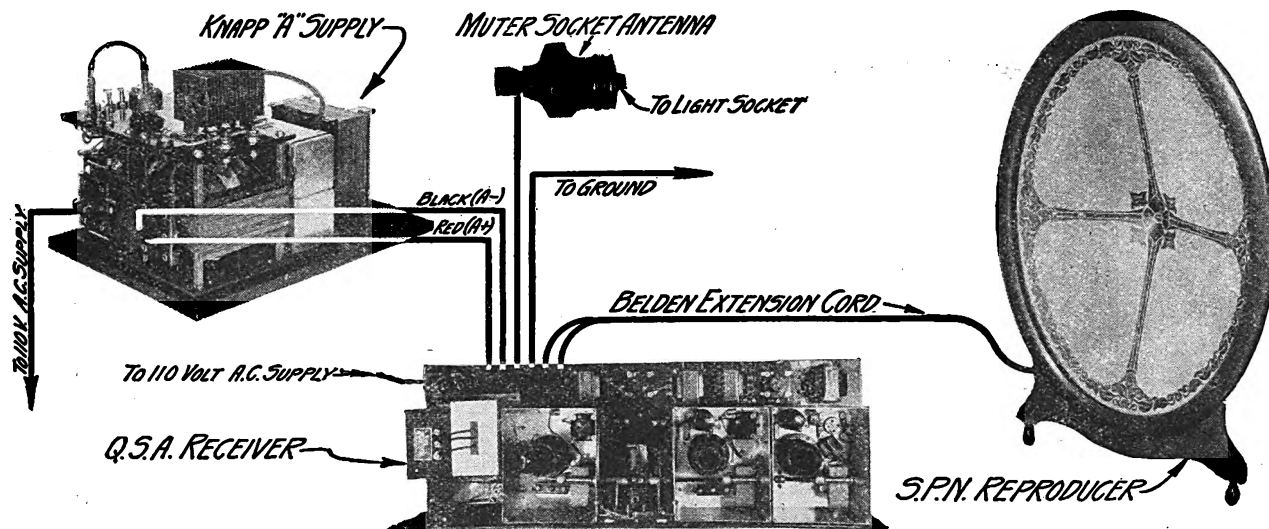


FIGURE 1: A VIEW OF THE SET FROM ABOVE



HOW TO WIRE THE SET

FIGURE 2: The solid red lines indicate wires that run under the sub-panel, the dotted red lines wires above the sub-panel. The instruments mounted on the sub-panel are in dotted black lines, those under the sub-panel in solid black.



THE OPERATING HOOK-UP

FIGURE 3: The self-contained "B" supply in the QSA-5 eliminates the necessity of "B" batteries or power-pack, and the receiver is made completely socket-operated by the use of the Knapp "A" supply.

placed in position by reference to Figure 2. The Aerovox Pyrohm resistance, Q1, together with the Aerovox Pyrohm 2000-ohm resistance, Q2, should now be mounted at the extreme right of the panel condensers (looking from the rear of the set). The XL Variodensers, K1 and K2, should be mounted on the Hammarlund condensers, B1 and B2. The assembly of the cans, C1, C2 and C3, may be resumed after mounting of the Hammarlund condensers, B1, B2 and B3. The can assembly should be completed with the exception of that part of the can which extends toward the back. This will facilitate the wiring which takes place later. The Hammarlund double drum dial, B, may now be placed in position with its attendant shafts. This completes the top assembly.

Referring to Figure 2 the location of the Yaxley 3-ohm rheostat, R3, will be noted on the left of the Westinghouse Micarta panel. On the right is located the Clarostat control, R4. The front panel may now be fastened to the sub-panel by means of the brackets, T1,

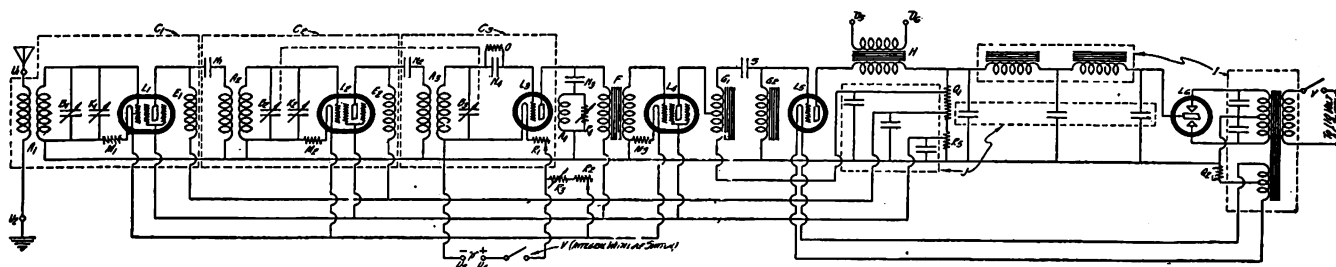
T2 and T3. The dial assembly should now be completed and the knobs for the Yaxley rheostat, R3, and the Clarostat volume control, R4, should be fastened in position by means of the set-screws. The set should now be turned over so that the front panel rests flat on the work bench. The Aerovox $\frac{1}{4}$ mfd. filter condenser, S, which is located beneath the sub-panel, should be securely fastened in position by means of two screws. The special home-made plate coil, A4, should next be fastened in position and the Aerovox 10-ohm resistor, M3, then should be tightly fastened in position by means of nuts and bolts. The plate coil, A4, is made of 80 turns of No. 30 double silk covered wire on a tube $1\frac{5}{8}$ inches outside diameter and 2 inches long.

Wiring the QSA-5 Receiver

It is always good practice in wiring up any receiver to have some definite method of procedure. Professional set builders generally follow some precedent plan such as the following.

Proceed to wire up the filament cir-

cuits of the various valve sockets together with their attendant rheostats or voltage regulating devices, such as fixed resistances, etc. Follow this with the grid and plate leads of the sockets, the coils and variable condensers. The grid and plate leads of the low-frequency transformers and output device should be wired next. Then connect the low-frequency transformers to their respective "C" and "B" battery binding posts. By-pass condensers should then be wired up and finally, the volume control. Then begin the wiring of the Thordarson power compact. Constant reference should be made to the picture wiring diagram in Figure 2 to eliminate the possibility of error. The high voltage wires should be connected to the rectifier valve. These wires issue from the side of the Thordarson power compact nearest the panel. The last low-frequency power valve also receives its filament current from this compact and should be wired up next. The Aerovox condenser block, J, should then be wired and following this the Pyrohm
(Continued on page 422)



THE CIRCUIT OF THE RECEIVER

FIGURE 4: The high-frequency amplifier is at the left, and the detector and low-frequency amplifier in the center. At the right is the "B" voltage supply, with its associated filter circuits. The output filter is shown at H.



MAKING READY FOR PICTURE RECEPTION

The construction and operation of the Cooley Rayfoto apparatus is only slightly more complicated than that of the average broadcast receiver. This picture shows the adjustment on the clutch that controls the recording cylinder.

THE ONWARD MARCH OF RADIOVISION

The modern marriage of radio to the optic sciences is not confined to television alone. Radiophotography is a fascinating and useful art that is much farther along the road to true practicability for the broadcast listener than television. This description of the Cooley Rayfoto apparatus for receiving photographs by radio should convince the fan that it is time to enter this interesting field.

By RICHARD LORD

THE latest field of activity for the radio experimenter is the visual reception of still and moving images. Radiovision and radiophotography are even now emerging from the laboratories of science into the home constructor's workshop.

For many years, the enterprising radio enthusiast has been dreaming of that day when he might see at a distance as readily as he now hears entertainment from remote points. His appetite for attainment along these lines has been whetted considerably by the recent spectacular public demonstrations by Alexanderson, Baird, Jenkins and Ives, of their methods of receiving moving images, and by Ranger, Alex-

anderson, Belin, Korn, Ives and Cooley, of their systems of high grade still picture reception.

With the possible exception of the last named system, the high cost of the apparatus involved, or the slow speed of transmission, places these systems out of reach of the practical experimenter.

The coming radio season, however, promises to bring the set builder full opportunity to participate in broadcast picture reception. In fact, scores of amateur experimenters are already receiving pictures in this manner. WOR of L. Bamberger & Company, at Newark, N. J., has been broadcasting Cooley Rayfoto pictures on a regular

schedule for some months, and many other broadcasting stations have applied for permission to conduct similar services.

The cost of essential parts for a Cooley picture recorder is \$150.00, exclusive of those standard radio parts which the amateur is likely to have on hand. Shadowgraph apparatus may also be available soon, capable of making crude moving silhouettes. The still picture apparatus produces high quality pictures in home of any subject to which the camera responds, provided it has fair contrast and not too much detail. From the "program" standpoint, still picture reception has real fascination to offer. Pictures of prominent

artists, of sporting and news events and "illustrations" to accompany radio lectures can be flashed into the home with the aid of picture recorders which the set builder can readily assemble.

It would be worth while for the experimenter to consider the present status of the picture broadcasting art; if he would derive the fullest benefit from the events of the coming radio season. So much has been prophesied and written about forthcoming developments that the experimenter may be led to expect too much, unless he familiarizes himself with the capabilities of the various systems likely to be offered him.

Regardless of the specific system of picture transmission used, the same basic process is employed in putting any picture on the air. It consists of the successive transmission of an electrical impression of the intensity of each spot on the picture until the entire surface of the picture has been explored. This process of dissecting a picture by areas in a predetermined progression, is called "scanning."

The more thoroughly a picture is scanned, that is, the more electrical impressions per square inch are made, the greater will be the detail. Conversely, the more impressions involved, the longer the time required to transmit a single picture.

Electrical impression of each such spot is secured either by reflecting a beam of light from the subject itself, or by rotating a photograph on a cylindrical drum, mounted on a threaded shaft within the focus of a photo-electric cell. The mechanism used in still picture transmission is similar to the old type cylindrical phonograph or dictaphone.

The light beam reflected from the subject upon the photo-electric cell varies in intensity with the shading that falls within the "scanning" of the beam. The space current through the photo-electric cell varies as the intensity of the light reflected upon it. When a black part of the rotating picture is exposed to the light beams, much light is absorbed and little reflected, causing a small photo-electric current. When a white portion is being scanned, much light is reflected to the cell, and a greater amount of current flows. In this way, shading of the picture is progressively converted into a varying electric current.

The light beam reflected from the picture to the cell is interrupted by a revolving shutter or other means, so that the resultant "picture signal" is a low-frequency current, fluctuating with the intensity of the picture. This signal is then combined with the carrier of the transmitting station and broadcast.



A PICTURE RECEIVED BY RADIO

Making allowances for the fact that this reproduction is made with a coarser screen than the original received picture, it can be seen that the Cooley apparatus has a fidelity that should give it high entertainment value to every fan and listener-in.

This is true of all systems. In television, however, the entire surface of the picture must be scanned in a sixteenth of a second. That is the only fundamental difference between television and radio photography.

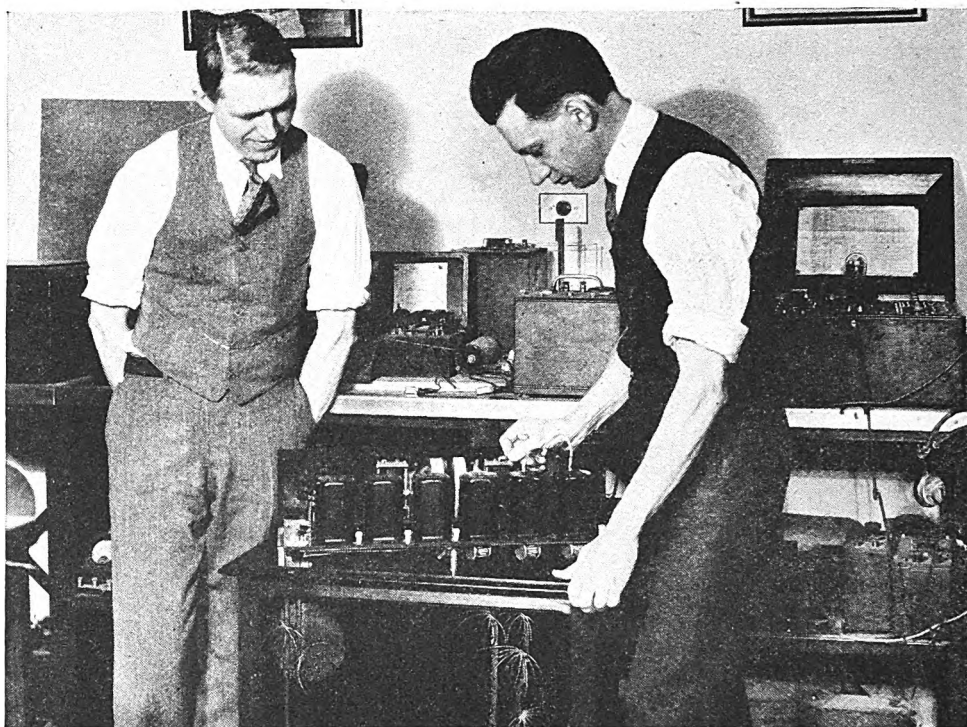
The distinction between still and motion picture transmission is, therefore, almost entirely a matter of the speed with which the complete image is sent and received. Radiovision is simply radiophotography speeded up to the point where complete picture is scanned and reproduced each sixteenth of a second. The ideal to be attained with radiovision is a high grade motion picture of any event occurring at a transmitting point.

The layman has been misled into believing that present-day television can present to his eye a visual reproduction of any event that his ear can hear by radio. There has been conjured for his imagination a football field spread before him on a ground glass screen, whereon he can watch the players, even

as the announcer describes the action taking place. We are a million miles from any such accomplishment. No one has the slightest suggestion, yet, of how this ideal may be arrived at. The reader who has understood the general principles already outlined can readily calculate for himself the magnitude of the problem of attaining true radiovision.

Reverting to actualities, the process of moving picture transmission consists in reflecting a ray of light from the subject to a photo-electric cell, progressively covering the subject each sixteenth of a second. To be practical for use on the broadcasting band, no higher speed of modulation than five thousand cycles is desirable. That means 5,000 picture impressions per second, or 312 each sixteenth of a second.

Furthermore, since the light must be reflected from the subject to the photo-electric cell, it must be reasonably close
(Continued on page 424)



ANOTHER TRIUMPH FOR THE SCREEN GRID VALVE

The design and construction of the Tyrman "70" has convinced the Laboratory Staff of this magazine that this receiver is another step forward in the ever-widening field of use for the screen grid valve.

Here's a Superheterodyne With Screen Grid Valves

Superheterodyne construction gets a new boost in the Tyrman "70" receiver, which incorporates a three-stage intermediate amplifier that makes use of screen grid valves. In addition to this feature, the receiver has a compactness and simplicity in construction and operation that is very unusual in this type of circuit.

By MORRIS M. SILVER

SIMULTANEOUSLY with the advent of the 222 screen grid valve on the market there appeared the Tyrman "70" screen grid Amplimax set. This is a superheterodyne designed especially for the use of the 222 screen grid valve. The circuit itself is of extreme interest to the radio enthusiast because of the high degree of amplification possible in this set, together with the possibility of very good selectivity without danger of cutting the side-bands, thereby assuring very faithful reproduction. A very short antenna, consisting of but a few feet of wire, may be used with this set with surprisingly good results.

Instead of the usual form of fre-

quency transformer a single coil of several hundred thousand ohms impedance is used so that the internal impedance of the valve may be more nearly matched.

Due to the high degree of amplification of this set it is essential that there be complete shielding of the coils and valves. An actual amplification of 30 to 50 per valve is possible in this set as against an intermediate-frequency amplification of 6 or 7 in ordinary superheterodyne circuits.

Properly designed apparatus is an important factor in this set. Background noises are particularly noticeable by their absence, and the 340 kilocycle im-

pedances which are used as the means of intermediate coupling assure a single spot reception.

The filament of the screen grid valve is similar to that of the UX-120 type low-frequency amplifier, and draws .125 amperes at 3.3 volts. It is important that the filament voltages of these valves are not exceeded beyond that of the given rating. A plate voltage of 135 volts is recommended in this set with a screen grid potential of 45 to 67½ on the screen grid valves, with a negative "C" bias of 1½ to 3 volts on the control grids.

Upon completion of assembly of this set the symmetry will become apparent

POPULAR RADIO WORK SHEET

THE TYRMAN "70" RECEIVER

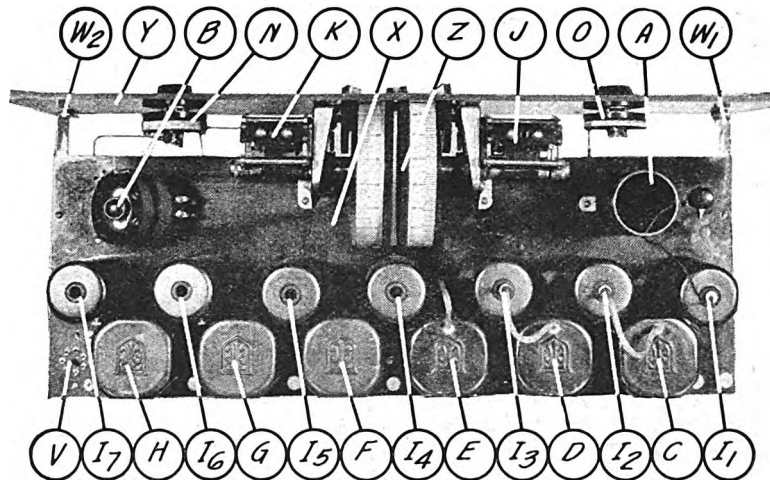
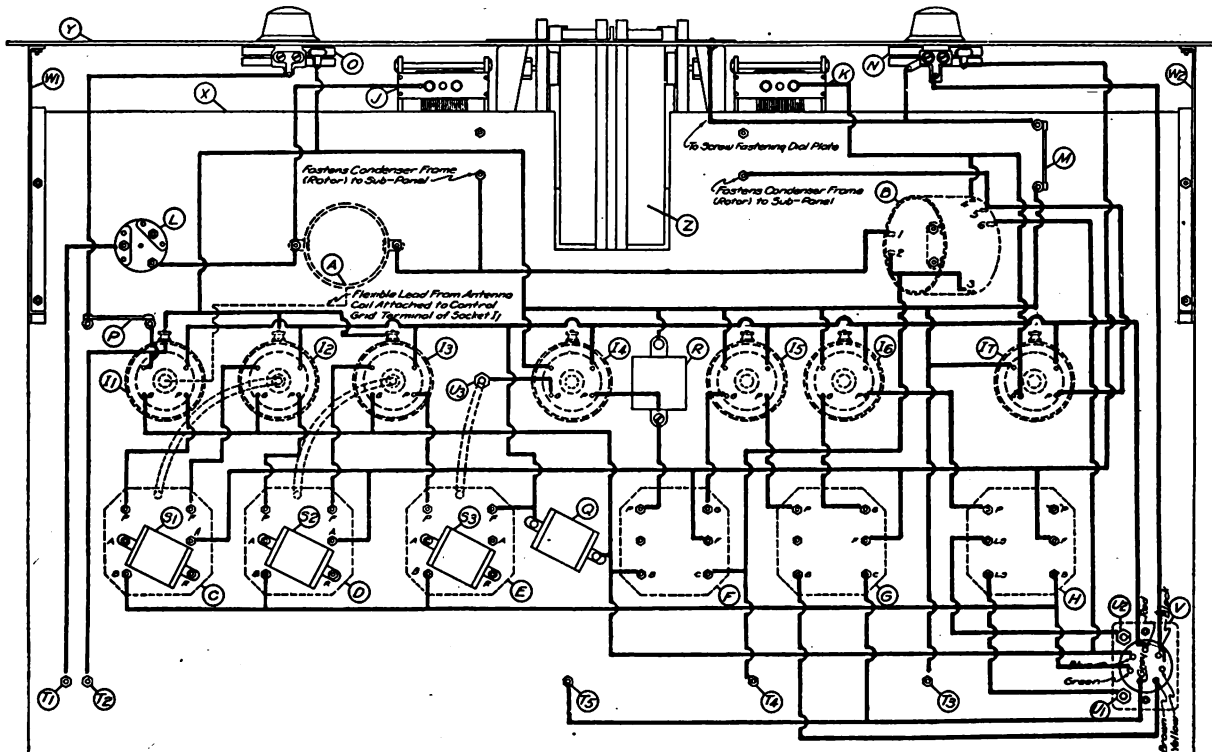


FIGURE 1: THE MOUNTING OF THE INSTRUMENTS

LIST OF PARTS USED IN BUILDING THIS RECEIVER

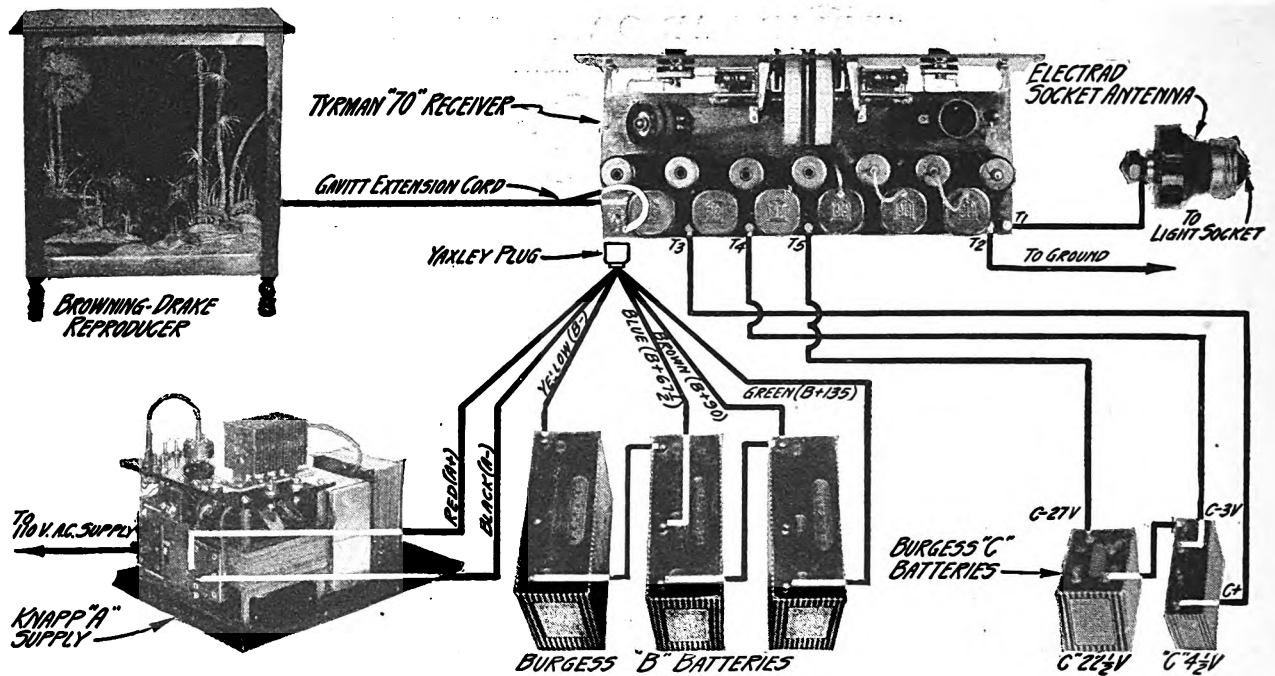
COST OF PARTS: *Not over \$127.00*

- | | | |
|---|--|---|
| A—Tyrman antenna coil, type 9-80; | L—Chelton midget condenser, 50 mfd.; | T1 to T5—Binding posts; |
| B—Camfield oscillator coupler, type 622; | M—Yaxley fixed resistance, 1 ohm, type No. 4-L; | U1 and U2—Phone tip jacks integral with Yaxley Cable Conductor Plug, V; |
| C, D and E—Tyrman shielded high-frequency impedance units, type 9-90; | N—Yaxley combination switch and rheostat, 15 ohms, type 915-K; | U3—Yaxley pup jack, No. 416; |
| F and G—Tyrman low-frequency transformer, type 3-30; | O—Yaxley rheostat, 25 ohms, type 125-K; | V—Yaxley cable connector plug with cable, No. 669; |
| H—Tyrman output transformer, type 3-51; | P—Yaxley fixed resistance, 15 ohms, type No. 815; | W1 and W2—Benjamin brackets No. 8629; |
| I1 to I7—Tyrman shielded sockets; | Q—Carter by-pass condenser, 1 mfd., No. 110; | X—Composition drilled sub-panel, 8 by 23 by 3/16 inch; |
| J—Camfield variable condenser, .0005 mfd., type No. 501; | R—Carter moulded condenser, .0005 mfd.; | Y—Composition drilled and engraved front, 7 by 24 by 3/16 inch; |
| K—Camfield variable condenser, .0005 mfd., type No. 251; | S1 to S3—Carter by-pass condensers, 1 mfd., No. 110; | Z—Tyrman double vernier drum dial; Wire, screws, nuts, etc. |



THE WIRING OF THE RECEIVER

FIGURE 2: All the wiring is done under the sub-panel, and is shown in solid red lines. The parts under the panel are in solid black, and those above in dotted black lines.



HOW TO HOOK UP THE RECEIVER

FIGURE 3: A light socket antenna is indicated in the above diagram, but under certain conditions it may be found that a short wire, 8 or 10 feet long, will produce better results.

and the general appearance will compare very favorably with any commercially-made receiver on the market.

The Assembly of the Instrument

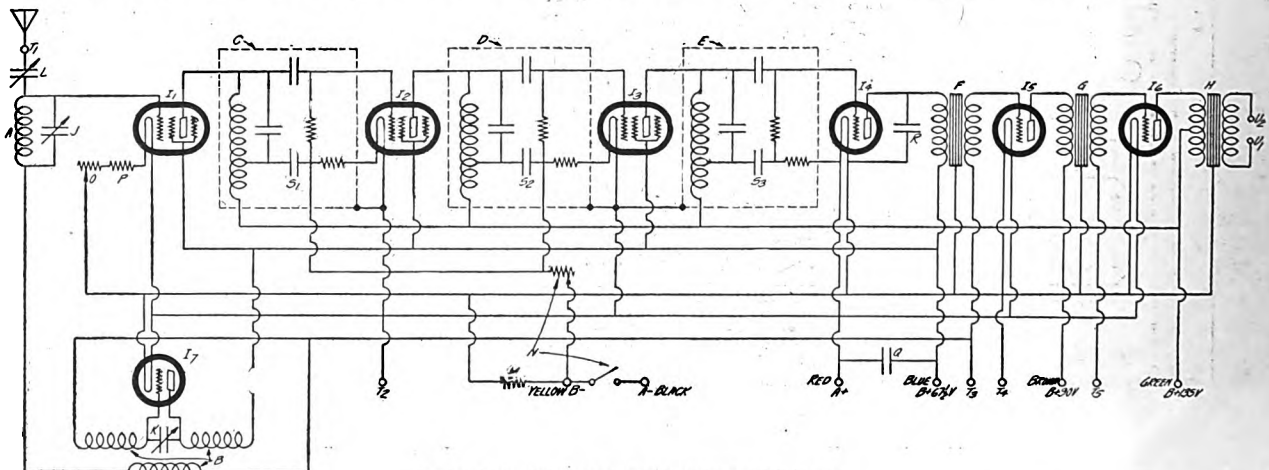
The sub-panel and panel are factory-drilled, which greatly assists the home or professional set builder in rapid assembly of parts. Referring to Figure 1 we note the three high-frequency impedances, C, D and E, are located at the right, the two low-frequency transformers, F and G, are located next to the three intermediate impedances, with the output transformer, H, at the extreme left.

These units should have their trade marks facing the front panel. Referring to Figure 2, the three 1 mfd. by-pass

condensers, S1 to S3, hook into the specially provided terminal screws of the high-frequency impedances. A Yaxley No. 699 cable socket, V, is conveniently placed at the lower right corner for battery connections. It will be necessary to remove the mounting bracket, as this cable receptor is positioned on top of the sub-panel. A Yaxley pup jack, U3, will be mounted between the third and fourth sockets. This is for the grid lead of the third high-frequency impedance. A flexible lead of the antenna coil, A, connects to the cap of the first valve. The grid leads of the first two impedances terminate in bushings that fit over the valve caps of the second and third screen grid valves. The oscillator coupler, B, is fastened next in

position at the right of the subpanel. Two variable condensers, J and K, .0005 and .00025 capacity are used for tuning the antenna and oscillator coupler, respectively. These are mounted with the Tyrman vernier drum, Z. Auxiliary brackets are used for the purpose of bracing the main brackets to the sub-panel. These also provide the rotor terminal of the condenser, permitting almost complete sub-panel wiring. Referring to Figure 2, the position of the rheostat O, which controls the filament of the first detector valve in series with the fixed resistance, P, may be ascertained. Likewise, the 15-ohm switching rheostat, N, which regulates the filament temperature of the second

(Continued on page 420)



THE CIRCUIT OF THE TYRMAN "70"

FIGURE 4: The complete shielding of the intermediate-frequency impedance units is indicated by the dotted lines at C, D and E. In addition, all the valves in set have shields.



Radio Helps on a Silver Fox Farm

Radio instruments have been used in the past to solve many unusual problems, but the application described below seems to the editors to be the most unusual example of radio ingenuity that has come to their attention.

By ELVA M. GILLCASH

IN Prince Edward Island, where the ranching of silver foxes originated, there has recently been developed, in connection with this industry, a new and interesting use for radio equipment. Silver foxes have proven a profitable source of revenue in this little province by the sea. The greatest barrier to success in raising them lies in the fact that the mother fox is possessed of an exceedingly nervous temperament, which is liable to manifest itself in curious ways if she is disturbed when her young ones arrive.

One cannot say with any degree of certainty whether or not a particular vixen is expecting a litter. However, if she fails to come out of her den, the presumption is that the important event has occurred. Then follows a

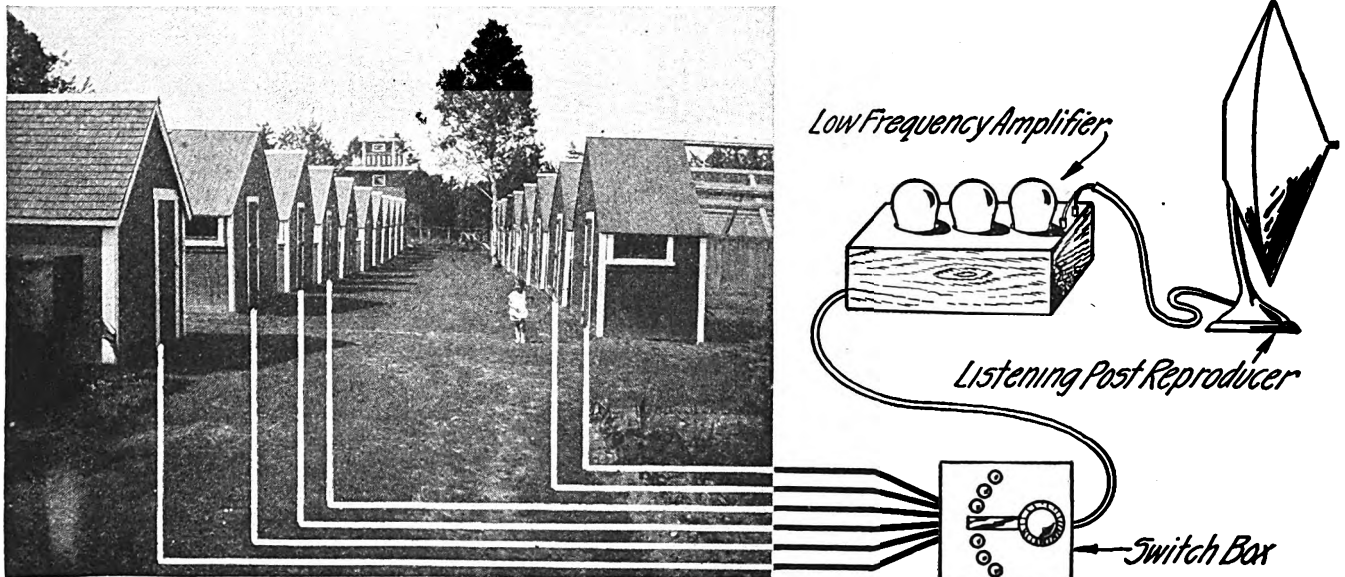
period of anxiety for the rancher. Has a new litter arrived? If so, are they living? Is the mother giving them proper care and nourishment, or is it advisable to give them to a foster-mother temporarily or permanently?

These questions can be answered by looking into the den; but in the majority of cases such an intrusion results in the vixen either killing the pups outright, burying them in the snow or clay, or starting to carry them around.

"Of two evils choose the lesser" is the policy followed by most ranchers, and this means that for three weeks the vixen must be left undisturbed. At the end of that time the rancher may discover a fine litter, or conditions may be such that he regrets not having made an investigation before.

Both these evils have, however, been overcome by one large ranch owner, Mr. W. K. Rogers, of Charlottetown. This is how he did it. Into each vixen's den he installed a very sensitive microphone, connected with a central switch in the watch tower. By means of a low-frequency radio amplifier the sounds in the den are raised to a volume sufficient to operate a radio loudspeaker.

By this means the ranch owner can, at any time, ascertain what is going on in any particular den, and govern his actions accordingly. The increased number of young foxes raised to maturity has more than justified the expense of installation and upkeep, and radio will undoubtedly become part of the equipment of every progressive rancher in the near future.

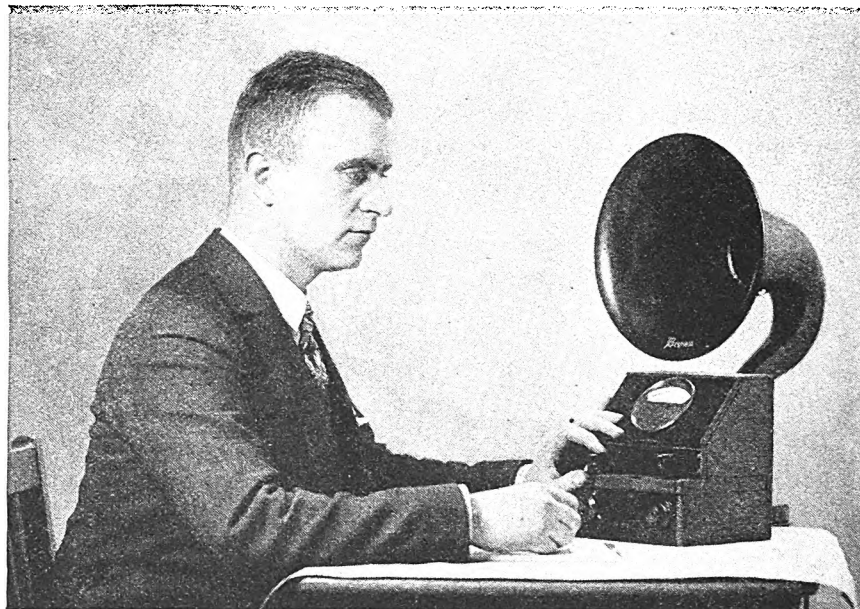


HOW THE INSTALLATION WAS MADE

Microphones were installed in every fox den, and connected through a switch box to an ordinary low-frequency amplifier and loudspeaker. In this manner the owner could listen in on what was going on in each den without the danger of disturbing the irritable vixens by a visit in person.

THE INVENTOR AND HIS WORK

Here is Dr. A. Ristow with the tele-control he devised. This simple instrument controls from a distance the receiving set of the Berlin police department.



Tuning With a Tele-Control

In the heart of Berlin a man sits at a small instrument and controls the receiving set of the Berlin police department with three small switches. The receiver itself is located in the outskirts of the city, well away from interference and other noises. The ingenious device used to accomplish this is described in this article.

By DR. ALFRED GRADENWITZ

IT is often found desirable to install radio receivers at a considerable distance from the listener's location. In fact, the existence of zones characterized by poor reception (e. g. in mines, in large cities, zones termed "radio shadow," etc.), as well as the proximity of electric motors, automatic telephone plants and the like, frequently make such a course imperative.

One case in point was the location of the police radio system covering the whole of Germany, and which had necessarily to be controlled from central Police Headquarters, in the very focus of Berlin traffic, where radio reception left much to be desired. This problem had been solved by installing the receiver on the outskirts of the city, in the suburb of Lichterfelde, where it was operated and tuned by special officials and whence any signals received were retransmitted over a special telephone line to the various offices at headquarters.

Realizing that this state of affairs was anything but satisfactory, a police officer who at the same time is a distinguished scientific worker, Dr. A. Ristow, has just devised an ingenious and most useful apparatus which enables the

actual receiving plant to be controlled from Police Headquarters without any need for employing special officials as heretofore and without any additional lines of conductors; in fact, without any but the telephone line so far required. This apparatus, which should prove useful in many other cases, enables the antenna and valves to be switched in and out and all tuning devices to be controlled from the listener's location about 10 kilometers away.

No loss of time, as compared with manual control, had, of course, to be entailed by the adoption of the automatic arrangement.

This arrangement utilizes on the one hand, the inversion of direction of the controlling current, and, on the other, its actual intensity. The mechanical energy used in connection with the remote control is supplied by a small electric motor the rotation of which is reversed by changing the direction of the controlling current. The switching and tuning devices to be operated are each time chosen automatically in accordance with the actual intensity of the controlling current. A resistance inserted in the controlling circuit enables the actual position of the tuning

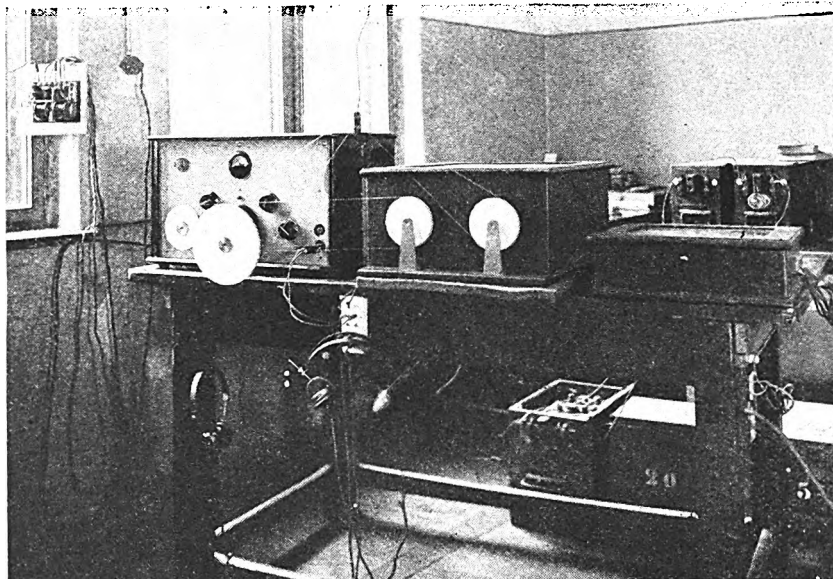
device to be always checked accurately.

At the place where the listener is posted (see Figure 1) there are, for him to operate, two double-pole switches, S1 and S2. The fulcrum of S1 is connected over a milliammeter with the central tapping of the primary of a transformer applied to the lines *a* and *b*. The fulcrum of S2, on the other hand, is connected to the ground. The contacts of S1 and S2, which in their position of rest are open, are connected up to the negative pole of a controlling battery, whereas these contacts while closed are applied to the levers of a three-pole switch, Sb, connected with three different voltages of the controlling battery. The listener's telephone is on the secondary of the transformer.

At the place where the radio receiver is installed, there is a connection leading from the central tapping of the primary of the transformer, across a polarized relay, PR, across the relays R1, R2 and R3, across the contact set 3 of R2, across W1 to the earth. The contact sets, 1, 2 and 4, are so arranged with regard to the clutches, K1, K2 and K3, that while R1 is making contact, the armature of K1 is attracted. While R1 and R2 are in contact, the armature

of K2 is attracted and while R1, R2 and R3 are in contact the armature of K3 is attracted. The axes of clutches K1, K2 and K3 are permanently connected with the gearing. W1 and W2 are permanently connected with the armatures of K1 and K2. The armatures of K1 and K2 control the tuning devices of the receiving apparatus, while the armature of K3 controls the switch earthing the antenna and the switch operating the heating current.

The electric motor is thus started clockwise or counter-clockwise according as the positive or negative pole of the battery from the listener's post is connected to the line leading to the place where the receiver is installed. When the three-pole switch Sb is making contact across contact 1, a small voltage (15 volts) is applied to the line, which just suffices to operate the first relay magnet R1, which in turn connects the magnetic clutch K3 of the gearing with an axis operating the antenna and heating current switches. When the same three-pole switch Sb is making contact across 2, the tension applied to the line will be 45 volts, which will cause a somewhat stronger relay magnet to be actuated at the remote end, thus disengaging the former smaller magnet and closing the magnetic clutch K2 with another axis operating the variable condenser. When, finally, the three-pole



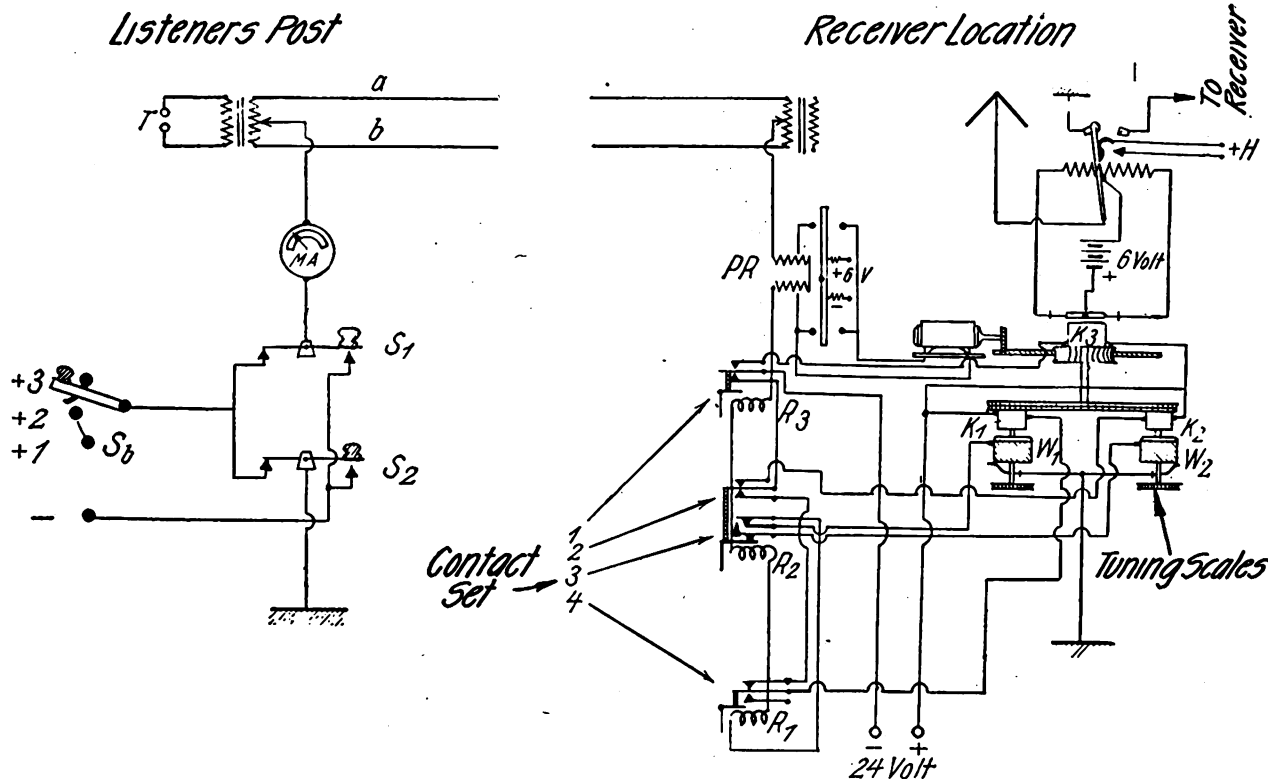
A RECEIVER TUNED BY ELECTRIC IMPULSES

The receiving apparatus shown here is tuned and switched "on" and "off" at a distance of seven miles by electric impulses that come over a single telephone line. Note the clutches attached to the tuning knobs and switches.

switch Sb is making contact across 3, a third relay magnet is actuated by the slightly higher voltage (48 volts), thus connecting the second tuning device with the gearing. The motion of the rotary condenser is transmitted by a disc, which throws in variable amounts of the resistance, W1 and W2, as

checked from the listener's post by a milliammeter.

An addition to the apparatus can be made for enabling even a set of spare valves to be taken into operation from the listener's post. This will practically exclude any risk of failure of the receiving set to operate properly.



THE CIRCUIT OF THE TELE-CONTROL SYSTEM

FIGURE 1: All tuning and switching of the receiver is done by means of the three switches, S1, S2 and Sb, in conjunction with the milliammeter. The apparatus makes use of both the direction of the current flowing in a and b and its intensity.

For the Modest Pocketbook— The LC-28 Junior

The LC-28 Junior is built on the same chassis as the LC-28, and embodies the same high-quality principles as older set, but is constructed so as to be within the reach of the fan of limited means. The set embodies two stages of high-frequency amplification using screen grid valves, a crystal detector, and a complete low-frequency amplifier. This assures the builder of real LC-28 quality—at a considerably lower price than before.

By LAURENCE M. COCKADAY



THE development of the LC-28 Junior receiver was undertaken with a number of definite ends in view. First was the attainment of true quality in reproduction. The timely development of the new carborundum stabilizer detector "tube" and the use of high-grade transformers in the low-frequency amplifier adequately fill this requirement.

This new crystal detector is an excellent rectifier, as it is sensitive to weak signals and reproduces naturalness of tone. It is simply inserted in the detector socket in place of the standard vacuum valve.

A feature of this receiver is the use of the completely drilled sub-panel used in the original model of the LC-28 described in the October, 1927, issue of *POPULAR RADIO*. In the LC-28 Junior receiver both the high-frequency and low-frequency amplifiers are mounted on the one sub-panel. The power supply is the only external unit.

While there is one less stage of high-frequency amplification in this receiver than in the older model, the two screen grid valves utilized in the high-frequency amplifier more than compensate by the greater amplification per stage they provide.

As with the LC-28 screen grid receiver, a description of which appeared in the April, 1928, issue of *POPULAR*

RADIO, the tuning units and shielding arrangements used in the original LC-28 receiver are again employed. The DC plate current of each screen grid valve is passed through a high-frequency choke. The primary of the coupling coils are left unused; the amplified voltage in the plate circuit of the preceding valve is impressed directly across the tuned secondary coil of the next valve through the medium of a small coupling condenser.

The screen grids are by-passed by the fixed condenser, H, to the filament circuit to prevent interstage coupling through the plate supply. The circuit diagram appears in Figure 4.

The construction of the receiver is simplified to such an extent that the set builder should be able to assemble and wire the receiver in one evening. The receiver when installed in the special console or cabinet made for it, presents an appearance in keeping with the highest priced manufactured sets.

The Construction of the Receiver

In building the receiver the same general constructional features should be followed as outlined for the original LC-28 receiver, a description of which appeared in the October, 1927, issue of *POPULAR RADIO*, except for the mechanical changes necessary for replacing the standard base type of socket

for the sub-chassis type sockets, P1 to P5, and mounting the two stage low-frequency amplifier on the right-hand end of the sub-panel, Y, in the space formerly occupied by the detector box shield. Filament resistors O1 and O2 are ten ohms each and are mounted underneath the sub-panel, Y, as shown in Figure 5. The 1 mfd. by-pass condenser, H, is added to by-pass the high-frequency current from the screen grid to the filament circuit. In addition there is a 2 mfd. output filter condenser, I, which is mounted underneath the sub-panel, Y, as shown in Figure 5. The filament resistors, O3 and O4, are four ohms each, and are also mounted underneath the sub-panel. These resistor units control the filament voltage on the two low-frequency valves.

The coupling condensers, K1 and K2, have been decreased to .00005 mfd. capacity. These two instruments, as well as the by-pass condenser of .00025 mfd., L, are fastened underneath the sub-panel and are shown in Figure 5.

The equalizing condenser, N, is fastened to the stator connection of the first tuning condenser, J1. This equalizing condenser, N, is used to balance up the condenser, J1, so that its dial reading will be approximately the same as the dial reading of the other two condensers, J2 and J3. The combination

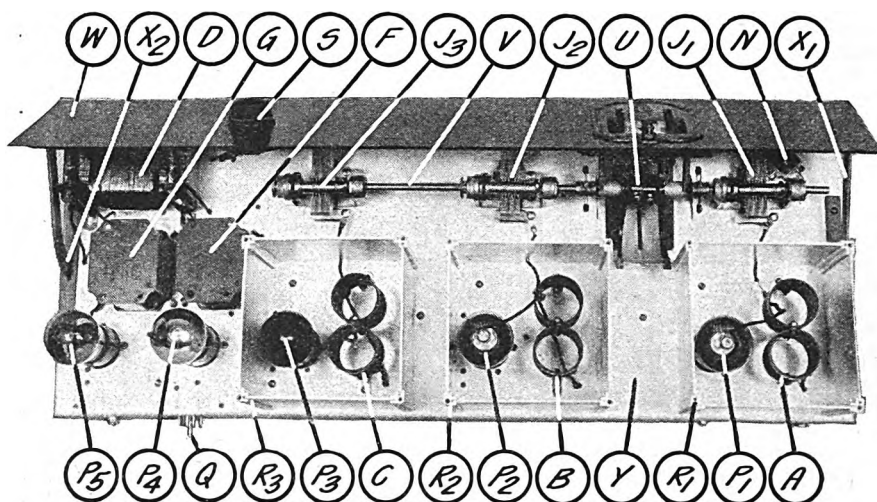
POPULAR RADIO WORK SHEET

THE LC-28 JUNIOR RECEIVER

LIST OF PARTS USED IN BUILDING
THIS RECEIVER

COST OF PARTS—Not over \$98.00

A, B, and C—Precision high-frequency transformers, type 4-B;
 D—AmerChoke, type No. 854;
 E1 and E2—Samson high-frequency chokes, type No. 125;
 F—AmerTran DeLuxe 1st stage low-frequency transformer;
 G—AmerTran DeLuxe 2nd stage low-frequency transformer;
 H—Aerovox filter condenser, 1 mfd., type No. 200;
 I—Aerovox filter condenser, 2 mfd., type No. 402;
 J1 to J3—Hammarlund mid-line variable condensers, .000275 mfd.;
 K1 and K2—Aerovox moulded condenser, .00005 mfd.;
 L—Aerovox moulded condenser, .00025 mfd.;
 M—Yaxley Junior jack, type No. 701;
 N—Hammarlund equalizer;
 O1 and O2—Aerovox wire wound resistances, 10 ohms, type 980;
 O3 to O5—Aerovox wire wound resistances, 4 ohms, type 980;
 P1 to P5—Eby UX sockets;

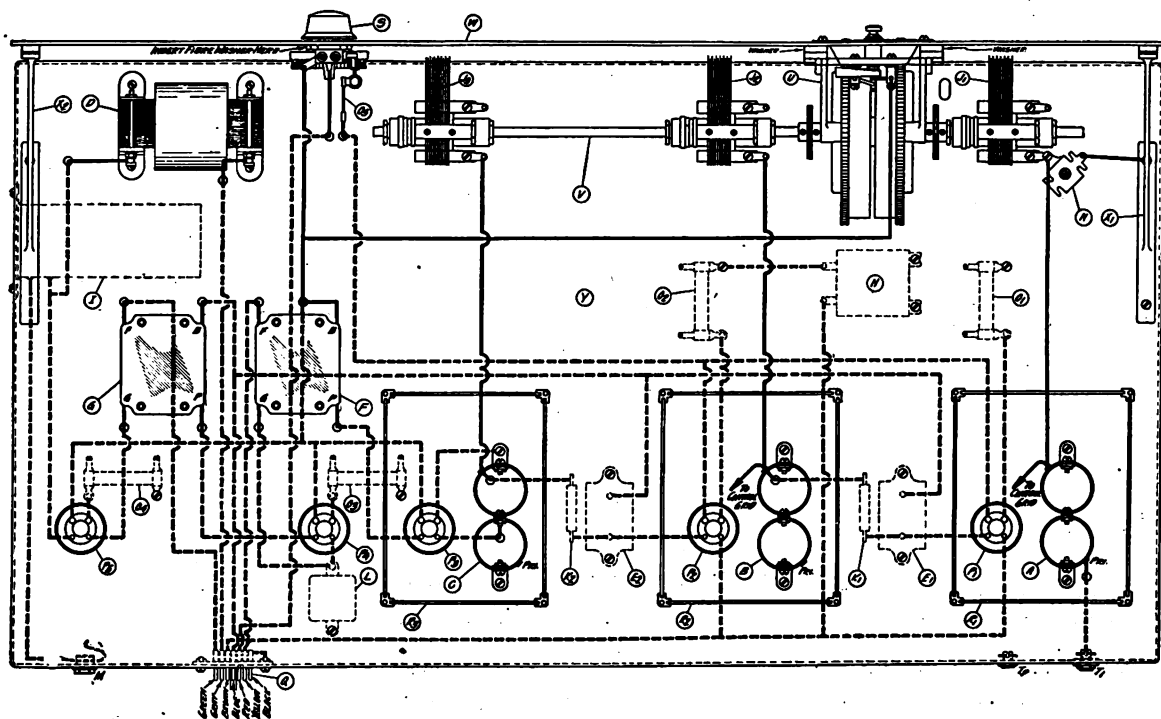


THE TOP VIEW OF THE SET

FIGURE 1: This view shows clearly the mounting positions for the instruments that comprise the low-frequency amplifier.

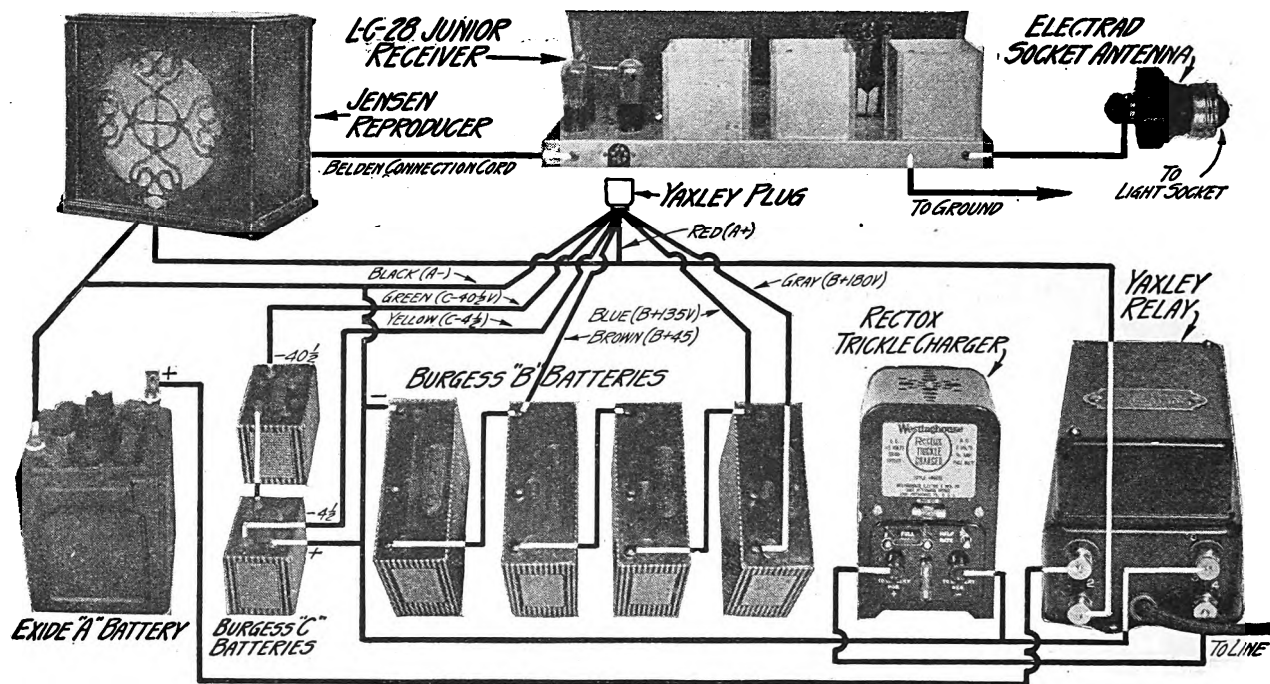
Q—Yaxley cable connector plug with cable, type No. 660;
 R1 to R3—Special small size aluminum box shields for the LC-28 Junior, made by the Aluminum Company of America;
 S—Yaxley combination switch and rheostat, 10 ohms, type No. 910-K;
 T1 and T2—Carter Imp plugs and tip jacks marked "antenna" and "ground," respectively, with insulating washers for the antenna;

U—Hammarlund double drum dial;
 V—Brass extension shaft, 10 inches long, 1/4 inch in diameter;
 W—Aluminum panel, 6 by 26 inches, drilled and decorated, made by Wholesale Radio Service Company;
 X1 and X2—Tait brackets;
 Y—Aluminum chassis for the LC-28 Junior, made by the Aluminum Company of America;
 Corvico Braidite hook-up wire, screws, nuts, etc.



THE WIRING DIAGRAM

FIGURE 2: The wiring is shown in heavy black lines, solid where it is done above the sub-panel, and dotted for wiring underneath.



HOOKING UP THE LC-28

FIGURE 3: This hook-up is entirely automatic in operation, being controlled by the switch on the receiver. The Yaxley relay controls both the charger and the field magnet of the Jensen speaker.

switch and rheostat, S, is ten ohms. The four-ohm resistor, O5, is an additional fixed resistor connected in series with the rheostat, S, to the common filament circuit of the two high-frequency amplifier valves.

The set builder should refer to Figure 1 and note the positions for mounting the first and second low-frequency transformers, F and G, the choke coil, D, the five sockets, P1 to P5, and the single circuit jack, M.

This completes the constructional work on the receiver and the wiring is ready to be started.

How the Receiver is Wired

The complete wiring details will be found in the picture wiring diagram

Figure 2. The set builder should follow these wiring instructions exactly. The wiring that is to run above the metal sub-panel, Y, is shown in heavy BLACK lines. The dotted BLACK lines indicate the wiring to be run below the sub-panel, Y.

This diagram carries out the theoretical circuit shown in Figure 4. In wiring this receiver, it is recommended that the set builder use insulated wire, such as Corwico Braidite hook-up wire.

The connection to the control grid is made to the terminal at the top of the screen grid valve. Make this connection with a piece of hook-up wire. Loop and solder in a circle the end which is to slip over the terminal cap at the top of the screen grid valve as

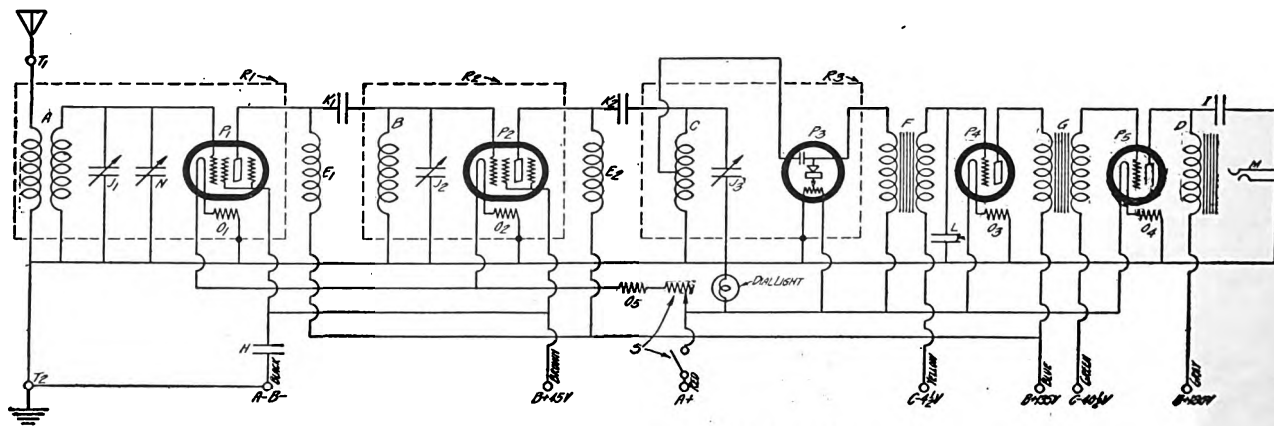
shown in the top view picture, Figure 1.

Re-check the wiring to be sure that no mistakes have been made. When this is done the receiver is ready for operation.

Operating Data for the LC-28 Junior

The LC-28 Junior may now be inserted in the top portion of the Corbett deck console. The Exide "A" battery, the Burgess "B" and "C" batteries, and the Yaxley automatic relay may then be inserted in the lower portion of the console. The Electrad light-socket antenna should then be attached to the tip jack T1. Of course an ordinary antenna may be used if desired; or a small antenna of a few feet may be

(Continued on page 432)



THE SCHEMATIC WIRING DIAGRAM

FIGURE 4: Through the use of screen grid valves, only two stages of high-frequency amplification are necessary. The crystal detector and low-frequency amplifier are at the right. The latter employs standard transformer coupling.

Synchronizing Television With Light Beams

Television's two great problems—speed sufficient for faithful reproduction of moving images, and proper synchronism of receiver with transmitter—are still awaiting a final and perfect solution. Proof that the challenge of these problems is not being declined is given in this article, which describes a method whereby synchronism is made automatic, being controlled by the light impulses of the received energy itself.

By PAUL L. CLARK

SENDING pictures by television may be likened to a military drill or maneuver having many lines of soldiers in regimental order, supervised by a single individual, the troops advancing as a single unit or as related units of the command, marching in step to rhythmic music. But what happens on the long turns, platoon formation? The line bulges a little in the center, recedes, advances, surges slightly and straightens out. It is largely a matter of alignment. Each man determines his position and speed by watching the rest of his outfit, and must be ever alert. So it is with the sending and receiving of pictures by apparatuses which are miles apart and yet which must keep in orderly arrangement the many parallel lines of shaded dots that make up the picture.

Experimenters on television term this aligning process "synchronizing," which means keeping the receiving set in step with the transmitter, so that the pictures will not bounce around the screen. You tune your radio set by *listening* to your loudspeaker; but only by *watching* the pictures on the small television screen is the experimenter given a clew to tuning his motor speed and framing the incoming pictures, the light flashes of which follow each other so fast that the eye fails to note a break in illumination. Once the picture is manually framed, no more attention to motor speed should be required, enabling the operator to control merely the brightness of the picture, letting synchronism take care of itself.

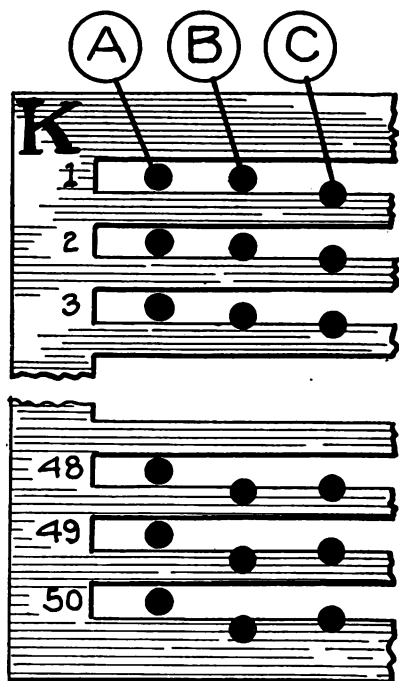
The experimental art has now arrived at the stage of sending 16 small pictures each second, each consisting of 50 lines having 50 shaded dots in each line, forming a picture which consists of 2,500 tiny areas, each of these areas being of a light or shade corresponding to one of the successive areas which

compose an illuminated object such as the bust of a person seated in front of the transmitter, certain elements of the transmitter being driven by a motor at constant speed.

The receiver must have a motor which runs at the same speed as that in the transmitter. Motor speed is regulated by varying the electric current in the field coils of the motor, a

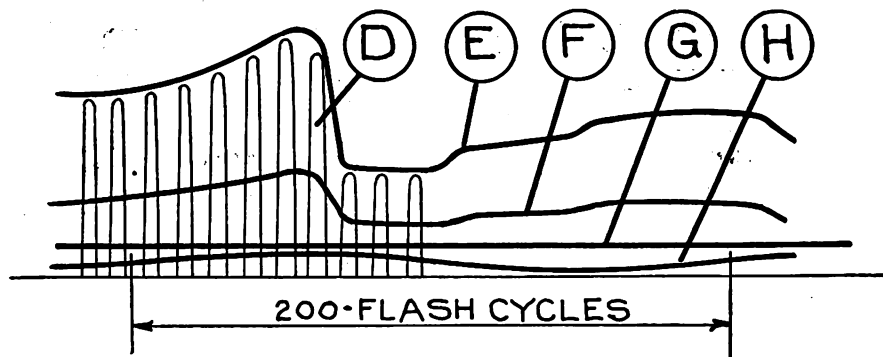
strongly excited field slowing down the motor. The motor of the receiver of Figure 3, in addition to the regular shunt winding, is provided also with an extra coil, G, which is wound so as to weaken the field and speed up the motor when current is passed through the coil. This is the coil which automatically regulates the motor speed, being energized by current which is set up in the local photo-electric cell, F, by virtue of light rays falling upon the cell, as described below. The motor should be manually started and brought up to run at a speed about one per cent below the speed of the transmitter motor, it being assumed for the time being that there is no current in the reverse field coil so that the received picture tends to travel slowly backwards across the screen, thereby indicating motor under-speed. The speed-correcting system herein described is designed to speed up the motor automatically at least two per cent, so that the speed with the reverse coil full strength will be about one per cent too high. The effect of the underspeed and overspeed field control is such, when applied successively at intervals a fraction of a second apart, as to hold the picture quite steady, the automatic feature of this device being merely a simple form of photo-electric light valve governed by different degrees of stoppage of successive flashes of the received picture light, these flashes being swept in the form of a swinging beam rapidly across a stationary grid or "light-chopper," made up of bars and slits, as shown in Figures 1 and 3.

The action of this valve is such as to vary the quantity of light which falls upon the photo-electric cell, the light used for this purpose being about 10 per cent of the light in each signal flash emitted by the neon lamp, these flashes being produced by signals received from the transmitter at the dizzy rate of many



A MAGNIFIED VIEW OF THE LIGHT CHOPPER

FIGURE 1: At A successive flashes from the neon lamp register with successive slits in the chopper, showing that the motor speed is too high. At B the flashes overlap the chopper bar, showing a speed drop from high to low. At C the flashes are intercepted by the bar, and half the light passes through the slits so as to fall on the photo-electric cell (F in Figure 3). This condition is the ideal interception of flashes to produce the least oscillation relative to synchronism.



TYPICAL ENERGY CURVES

FIGURE 2: At D are indicated the neon lamp flashes, 40,000 per second, is the total flash-energy applied to delineate the image on the screen. F indicates the energy reflected by the small mirror (C in Figure 3) to fall upon the chopper. G indicates the maximum illumination required on the photo-electric cell to compensate for one per cent underspeed. H is the approximate synchronizing cycle made up of 200 flashes.

thousands during each second. The cell is connected through an amplifier so as to supply energy to the pole-tip coil of the motor, so that bright light on the cell speeds the motor up; dim light slackens the speed; intermediate light flashes, as shown at C in Figure 1, falling upon the cell produce a neutralizing effect essential for accurate synchronizing.

The transmitter motor in Figure 3 drives the scanning disk consisting of 50 concave mirrors arranged at gradually increasing angles in the form of a spiral, so that as the scanner is rotated successive vertical lines of the illuminated image are traversed, point by point, by a single turn of the scanner; and all points of the image are successively changed into corresponding electrical currents by the photo-electric cell and sent to the receiver by a suitable broadcasting set or wire line. The chopper which is placed against the illuminated image is made of a glass plate, 3 inches square, on which are photographed 50 blackened bars each about as wide as a darning needle, alternating with transparent slits of equal width; so that as the scanning beam, SB, rapidly sweeps across the image, due to the rotation of the scanner, a series of lighted picture dots alternating with uniformly dark spots which are formed by the black chopper bars, is focused by the concave mirrors on the scanner, so that the light or shade of each illuminated picture area, alternating with the black chopper areas, falls upon the cell, producing therein a series of electrical currents derived from the bright picture areas, alternating with the electrical currents of extremely low and uniform energy, the latter impulses being derived from the low intensity of the light reflected by the dull surface of the black bars. The advantage of using a chopper in the transmitter is seen to lie in

its ability to break up the picture into a large number of disconnected, equispaced areas or lines which, when swept by a pointed beam, give rise to a corresponding number of instantaneous successive current impulses in the photo-electric cell and in the circuit which supplies current to the cell. The number of these impulses which are produced and transmitted in a single second of time, is technically called the "picture point frequency," which we will assume to be 40,000 per second. Changing the series of instantaneous currents into an alternating current by means of a suitable transformer, we find that in each 1-40,000th second we have a complete electrical action or wave which is made up of two parts, one being the positive picture signal which may be either strong or weak, depending on the shade of the picture dot, the time during which this half-wave is formed being 1-80,000th of a second; the other half of the wave being the negative or low intensity chopper bar signal of constant value.

Now, it is evident that if we have a receiving scanning system similar to that of the transmitter and run them both at the same speed, and if similar choppers are used, we will find that during each successive 1-80,000th second the focused scanning beams will simultaneously register: first, upon corresponding bars; second, through corresponding slits, in both apparatuses; so that when the beam is sweeping bar number 1 in the transmitter, the receiver beam is sweeping bar number 1 of the receiver; and 1-80,000th of a second later, the two beams will simultaneously sweep across slits number 2 of both pieces of apparatus. The above condition is that prevailing during exact synchronization, showing that the picture receiving set is per-

fectly timed. This idealistic assumption is, however, a little more than we can hope to obtain for periods of more than a few seconds. But we can attain a close registration by limiting the deviation to less than the width of a single slit, *i. e.*, a maximum error of cross-travel of less than one per cent, by providing a reasonable margin of excess energy in the motor-speed compensating circuit of the receiver. Too much cross-travel necessitates manual rephasing.

In order to obtain zero illumination on the cell, F, and consequently no current in the polarity reverse coil, G, throughout both halves of a given picture flash cycle during which cycle are transmitted a complete picture point luminous signal followed by a complete low energy black bar signal, it is evident that the luminous signal must have struck the chopper in such a way that it is entirely stopped by one of the chopper bars as shown at the lower part of the vertical series, B, in Figure 1, due to faulty synchronization resulting from overspeed; for it can be seen that for accurate synchronization the local scanning element should instantaneously be in such an angular position as to reflect the pointed conical beam emanating from the simultaneously produced neon lamp flash, so that the point of the beam shoots squarely against the edge of a corresponding slit of the chopper, as shown at C in Figure 1, at the exact middle of the 1-80,000th second during which the flash occurs. Darkness or bright light on the cell can persist only on account of continued overspeed or underspeed which produce respectively a slightly advanced or retarded scanning element.

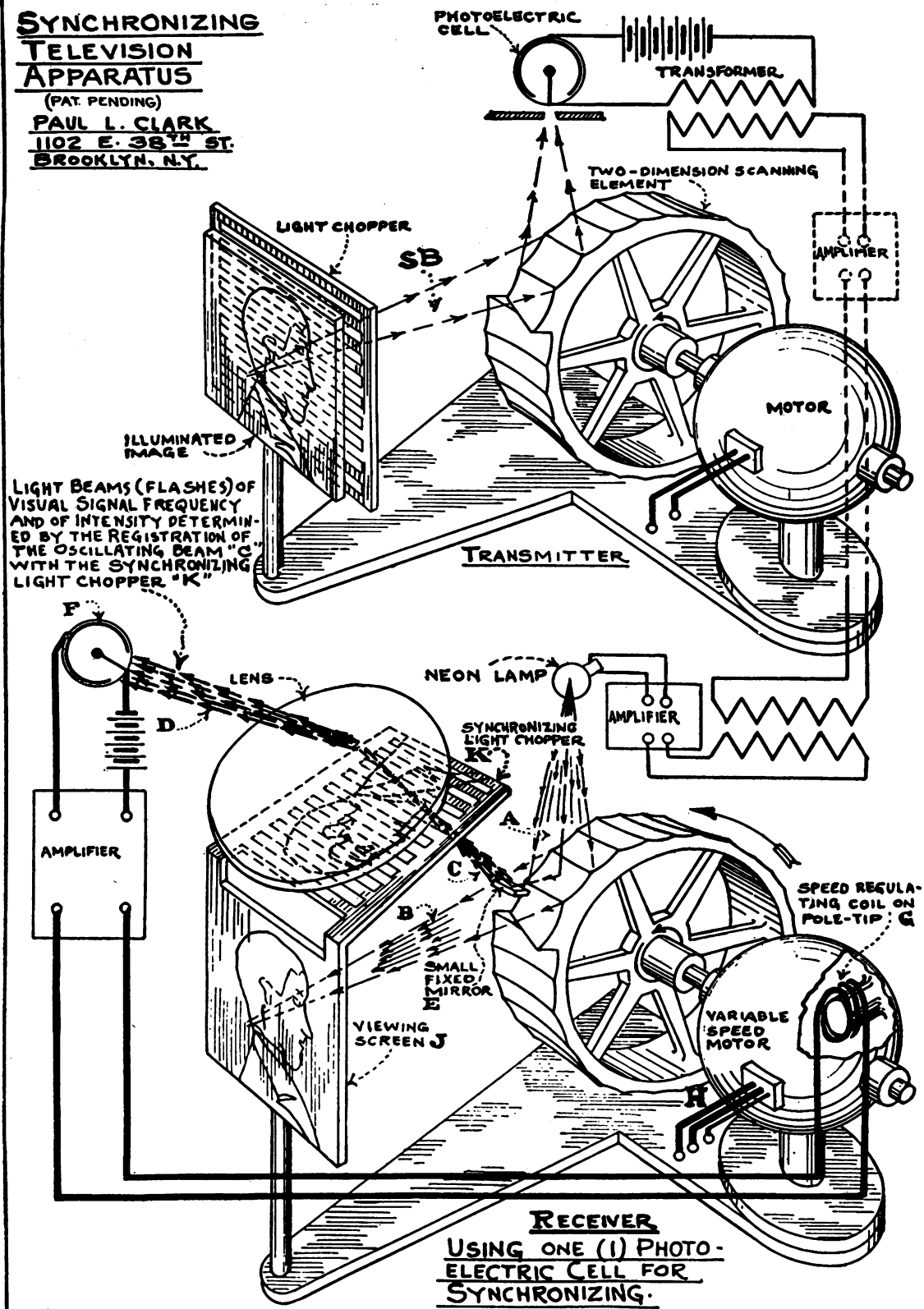
As we have assumed the motor to be normally, say, one per cent underspeeded, it will start to slow down from true synchronous speed until it reaches a speed which is one per cent too low, *provided there is no energy supplied to the speed-up coil*, and will backwardly deflect the signal flash beams so that some of them instantaneously pass squarely through the slits as shown at A in Figure 1. This illuminates the cell with full light and excites the speed-up coil with maximum energy, causing the motor and scanner to advance the reflected signal beams a slight degree *ahead* of registration, until light is again shut off from the cell so that the cell circuit ceases to supply excitation to the coil, G, and another drop in speed occurs. This alternate speed-up and slow-down period may be called a "synchronizing cycle." The receiver motor is of about 1-30th h.p., 960 r.p.m., with regulation

(Continued on page 419)

SYNCHRONIZING TELEVISION APPARATUS

(PAT. PENDING)

PAUL L. CLARK
1102 E. 38TH ST.
BROOKLYN, N.Y.



HOW AUTOMATIC SYNCHRONISM IS ACCOMPLISHED

FIGURE 3: The use of "light choppers" of similar dimensions in the transmitter and receiver is the key to Mr. Clark's solution of the synchronization problem, shown diagrammatically above. The transmitting scanning element scans the image through a light chopper; hence it delivers to the photo-electric cell series of light lines alternating with dark lines caused by the bars of the chopper. At the receiver part of the light energy of the neon lamp is reflected by a small mirror through another light chopper to a photo-electric cell whose output control a speed regulator on the receiver scanning device motor. It is the registration of the light and dark flashes on the second photo-electric cell that is used to bring about proper synchrony.

POPULAR RADIO WORK SHEET

THE AC VICTOREEN SUPERHETERODYNE

LIST OF PARTS USED IN
BUILDING THIS RECEIVER

COST OF PARTS—Not over \$139

- A—Victoreen antenna coupler, No. 160;
 B—Victoreen coupling unit, No. 150;
 C1 to C4—Victoreen high-frequency transformers, No. 170;
 D1 and D2—Victoreen variable condensers, .0005 mfd., comprising the Victoreen master control unit, type VU;
 E1 to E4—Benjamin 5-prong sockets, type No. 9036;
 E5 to E8—Benjamin Cle-ra-tone sockets, type No. 9040;
 F—Victoreen filament lighting transformer, No. 326;
 G1 and G2—Victoreen low-frequency transformers, comprising the Victoreen 112 unit;
 H—Victoreen rheostat, 1/2 ohm;
 I—Victoreen potentiometer, 30 ohms;
 J—Victoreen potentiometer, 400 ohms;
 K—Yaxley double-pole, double-throw jack switch, type 760;
 L and M—Victoreen switch, type 333, and plug unit;
 N1 and N2—Aerovox moulded condensers, .0005 mfd., with clips for grid-leak mounting;
 O1 and O2—Durham metallized resistors, 2 megohms;

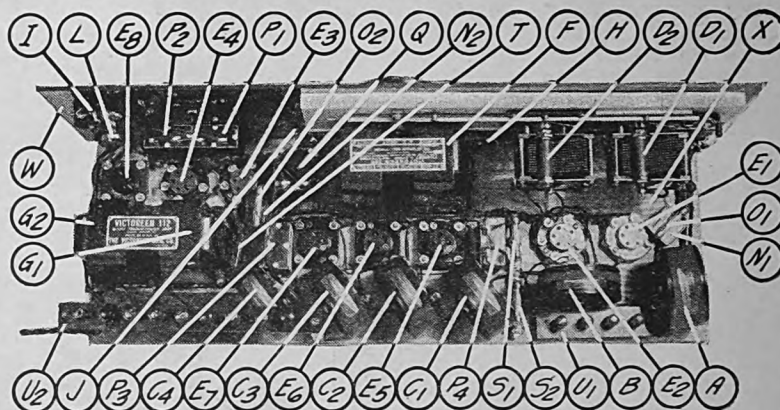
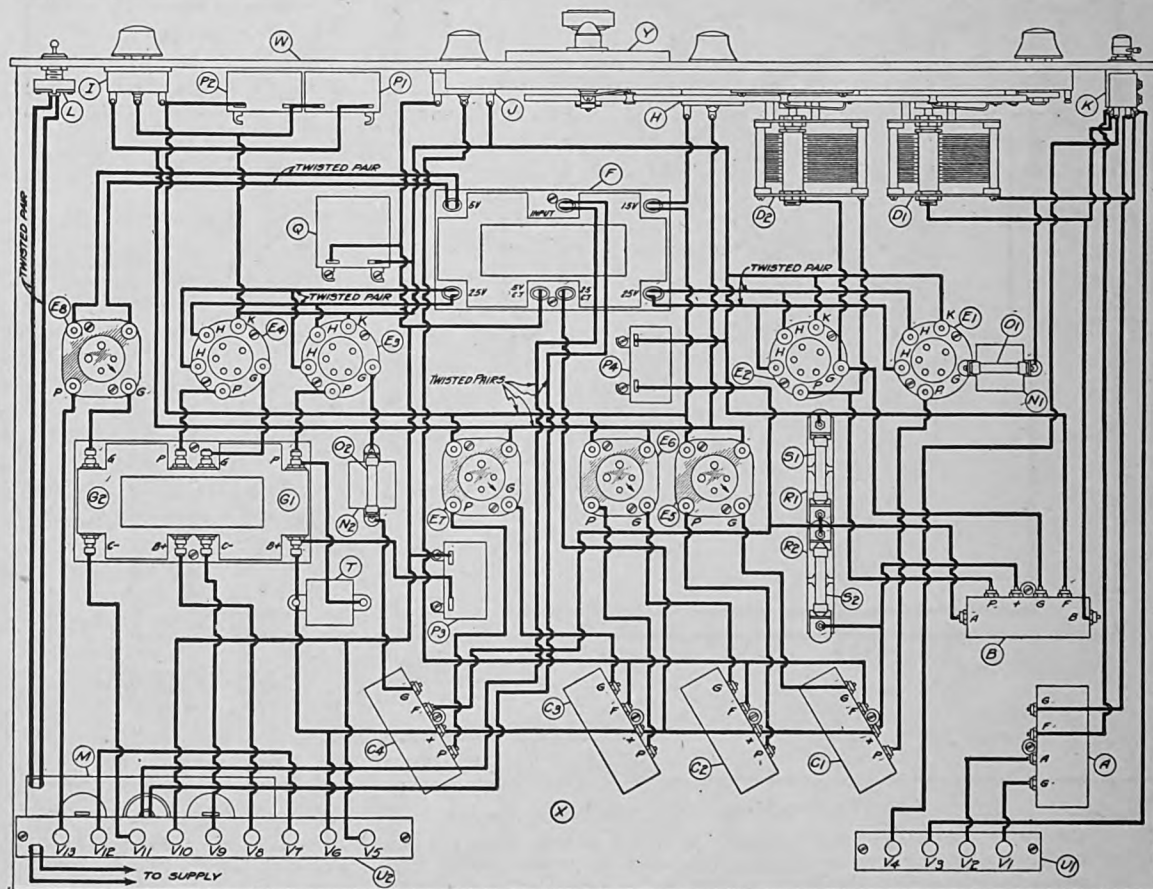


FIGURE 1: THE TOP VIEW OF THE SET

- P1 to P4—Acme Parvolt by-pass condensers, 1 mfd., Series A;
 Q—Acme Parvolt by-pass condenser, 2 mfd., Series A;
 R1 and R2—Lynch single-resistance mountings;
 S1—Durham metallized resistor, .05 megohm;
 S2—Durham metallized resistor, .25 megohm;
 T—Aerovox moulded condenser, .005 mfd.;

- U1—Bakelite binding post strip, 1 1/4 by 5 by 3/16 inch;
 U2—Bakelite binding post strip, 1 by 9 3/4 by 3/16 inch;
 V1 to V13—Binding posts;
 W—Bakelite front panel, 7 by 26 by 3/16 inch;
 X—Wooden baseboard, 9 1/2 by 25 by 1/2 inch;
 Y—Marco Vernier Dial, type No. 192.
 Wires, screws, brackets for mounting binding post strips, solder, etc.



THE WIRING OF THE SET

FIGURE 2: All the wiring is done above the baseboard, and is shown in heavy black lines. The instruments are outlined in light black lines.

The Victoreen Socket "Super"



The Victoreen AC superheterodyne combines the qualities that have made this circuit nationally popular with the advantages of operation from the AC lighting lines. Here are the constructional details for the new model.

By P. R. LECKY

TO the average home builder and even to the more experienced professional set builder the superheterodyne is always of intense interest. Probably one of the best examples of the successful "super" construction is the well-known Victoreen. In keeping with the general trend of the elimination of batteries the new AC Victoreen incorporates the best practices of the radio art. This is accomplished without loss of the distance-getting propensities for which this set is famed.

It also has the added advantage of either loop or antenna operation by means of a convenient switch. This feature is especially desirable with the approach of summer, for while the loop is not a cure-all for static, it may certainly be used to advantage in helping to reduce this condition.

Especially noteworthy is the fact that the Victoreen high-frequency transformers are adjusted at the factory to a precision within one-third of 1 per cent, which tends toward selectivity. Internal adjustments, also factory-made, discourage interstage oscillation, which permits the potentiometer to be used as a volume control and not as a loss.

A long aerial is not necessary with this set; in fact, one that is 50 feet long is ample, for any length greater than this brings in much unwanted interference and undesirable noise.

How to Mount the Instruments

In the building and wiring of the Victoreen superheterodyne our first care is the preparation of the baseboard. This baseboard should be sandpapered and stained. After the base-

board is dry we may lay the template, which is supplied by the manufacturer of the kit, in position and punch mark the crosses which designate the location of the mounting screws for the various instruments.

Now mount the sockets, E1, E2, E3, E4, E5, E6, E7 and E8, after making sure that they have the necessary lugs attached. Fixed condensers N1 and N2 should then be fastened to sockets E1 and E3, respectively. The condensers, P1, P2, P3, P4, and Q, should then be placed in position. Follow this by locating the grid-leak mountings, R1 and R2, and fastening them down. The antenna coupler, A, and the oscillator coil, B together with the intermediate transformers, C1, C2, C3 and C4, should then be fastened down. The low-frequency transformer unit, G1 and G2, which is a single unit, should then be screwed in position after fastening the necessary lugs in place. The Victoreen transformer, F, and the Victoreen switch and plug unit, M, should be omitted at this time to facilitate the wiring. The antenna or loop binding post strip, U1, should be fastened in position with lugs under the nuts of the binding posts. Figure 1 shows the position of the parts.

We may now assemble the front panel. The Victoreen master control unit containing variable condensers D1 and D2 should be first mounted, followed by the $\frac{1}{2}$ -ohm, H, the 400-ohm potentiometer, J, and the 30-ohm potentiometer, I. The lugs should now be placed on these various instruments and it might be well to tin them to facilitate the wiring later on. The switch, K, should be mounted in position be-

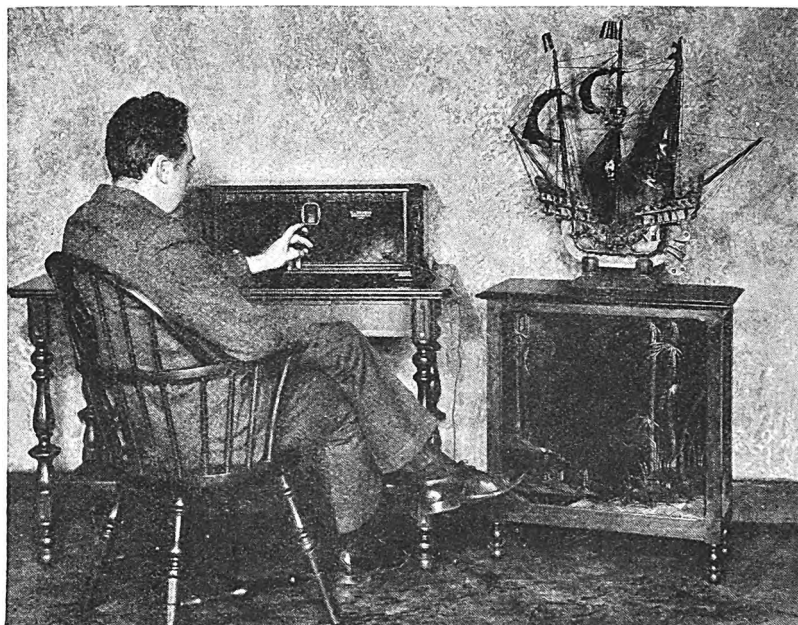
neath the Victoreen master control unit and the lugs should be bent to widen the space necessary for ease of soldering.

The knobs may now be put in position and the Marco dial template should now be mounted according to the instructions that come with it. The switch, L, should not be used at this time. The panel should then be laid aside for the present.

Wiring the Victoreen AC Set

Figure 2 shows the complete wiring of the receiver. Commencing with terminal K of socket E1, run a wire to terminal K of socket E2, thence to the terminal nearest the front panel of the grid-leak mounting R1. Continue this wire to one terminal of condenser P4, then to one terminal of condenser Q. From this same terminal of condenser Q, run a wire to terminal K of socket E3, and from there to terminal K of socket E4. This wire continues to condensers P1 and P2, and fastens to both of the right-hand terminals of these two condensers. The filament of the three intermediate sockets, E5, E6 and E7, should then be wired up. It will be noted that beneath the left-hand terminal, F, of socket E5 there are two lugs. One of these lugs will be used for wiring the filament circuit, so a wire should be run from the left terminal, F, of socket E5 to the left-hand terminal of socket E6, from there to the left-hand terminal of socket E7, and from there to the left terminal of condenser P2. A lead approximately seven inches long should be left on the terminal of P2. Connecting a wire to the right-

(Continued on page 428)



Screen Grid Quality in a Low-Priced Receiver **The Harkness Screen Grid "5"**

The high-quality reception made possible by screen grid valve amplification is now available in an extremely low-priced set, due to the perfection of the Harkness Screen Grid "5" receiver. Actual practice has proved the excellence of this receiver, and its low price and easy construction are sure to make its popularity nationwide.

By JOHN R. HUGHES

THE intense interest which greeted the introduction of the screen grid valve has been fully justified by the reports which have followed its use. Its relatively high amplification factor gave promise of great sensitivity and distance possibilities. Since the advent of this valve engineers throughout the country have been working on various circuits with the idea of evolving something simple and easy to build; at the same time combining the present-day requisites of a radio set, namely, quality and sensitivity. As the result of considerable laboratory endeavor Mr. Kenneth Harkness has evolved the Harkness Screen Grid "5" receiver.

The fact that this set may be built in less than three hours, because of the ease of assembly and simplicity of wiring, holds an especial appeal for the home builder who is not as experienced as the professional set builder. Perhaps the biggest advantage is the consideration of price, which is much lower than many five-valve sets upon the market at the present time.

Probably the most distinctive feature of this new circuit is the method of controlling oscillation and volume of the screen grid valves. The two screening grids are attached to the center arm of a 500,000 ohm potentiometer, which is connected across 45 volts positive (+) and "B" negative (—). By means of this high resistance voltage divider the potential of the screening grids of both valves can be varied from zero to 45 volts (+). At zero potential the receiver is practically "dead." Signals from the strongest local stations become inaudible. However, as the potential on the screen grid is increased the volume correspondingly increases until at a position very closely approaching the full 45 volts the set becomes extremely sensitive and a little beyond this point a condition of oscillation may be brought about.

Another important feature of the circuit is the method of interstage high-frequency coupling which is responsible for the sharp selectivity of the set without appreciable sacrifice of sensitivity.

Hitherto most of the screen grid sets have used the tuned plate method of coupling or a standard tuned-high-frequency circuit with special 1 to 1 ratio high-frequency transformers. These circuits have been necessary because of the high plate impedance of the screen grid valve and an appreciable amplification gain could only be obtained by an external plate circuit impedance that closely approached the impedance of the valve plate impedance itself.

In the earlier tuned plate circuits the selectivity was not all that could be desired. However, in the Harkness circuit neither of the above methods is used. Instead, a high impedance high-frequency choke is connected in the plate circuit of each screen grid valve and the plate is *capacitively* coupled to the screen grid circuit of the succeeding valve. In this manner the high external plate impedance of each screen grid valve is obtained and a very large high-frequency gain is obtainable, but sharp selectivity is secured by the tuned grid circuits and the capacitive interstage

POPULAR RADIO WORK SHEET

THE HARKNESS SCREEN GRID "5"

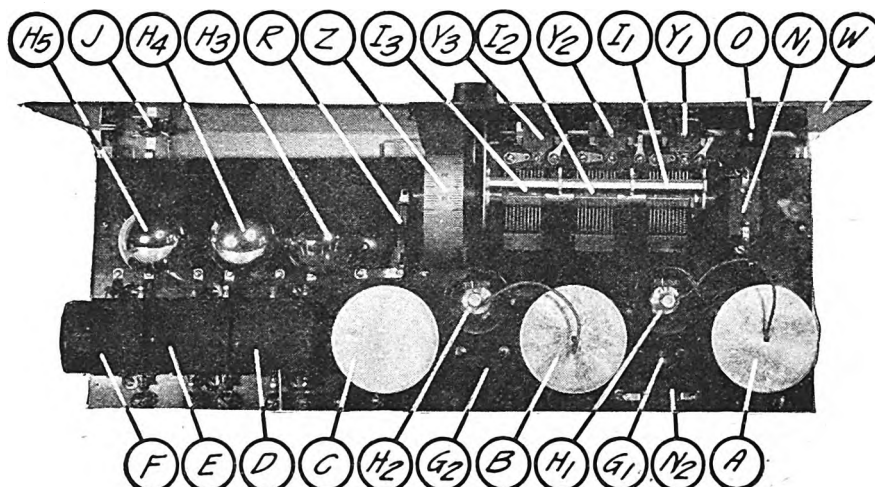


FIGURE 1: THE TOP VIEW

LIST OF PARTS USED IN BUILDING THIS RECEIVER

COST OF PARTS—Not over \$56.00

A, B, C—Harkness high-frequency transformers, types SG-1, SG-2 and SG-3;
 A1, B1 and C1—Harkness aluminum coil shields;
 D and E—Harkness low-frequency transformers, type T-500;
 F—Harkness output filter unit;
 G1 and G2—Harkness high-frequency chokes, type R-85;
 H1, H2, H3, H4 and H5—Eby UX sockets;
 I1, I2 and I3—U. S. L. 3-gang variable condensers, .00035 mfd. capacity in each section;
 J—Carter short jack, type No. 1;

K—Aerovox moulded condenser, .0001 mfd.;
 L—Aerovox moulded condenser, .00025 mfd.;
 M—Aerovox moulded condenser, .001 mfd.;
 N1 and N2—Aerovox by-pass condensers, .5 mfd., type 250;
 O—Carter Imp battery switch;
 P—Carter fixed resistors, 10 ohms, type H-10;
 Q—Carter fixed resistor, 1 ohm, type H-1;
 R—Aerovox grid-leak mounting equipped with Aerovox grid-leak, 2 megohms;

S—Binding posts;
 T—Carter potentiometer, 500,000 ohms, type 55;
 U—Aerovox moulded condenser, .00025 mfd.;
 V1 and V2—Harkness one inch sub-panel bracket;
 W—Bakelite drilled and engraved front panel, 21 by 7 by 3/16 inch;
 X—Bakelite drilled sub-panel, 20 by 7 by 3/16 inch;
 Y1, Y2, Y3—Hammarlund equalizers;
 Z—Silver-Marshall drum dial;
 Corwico Braidite hook-up wire, screws, nuts, clips for control grid connectors, etc.

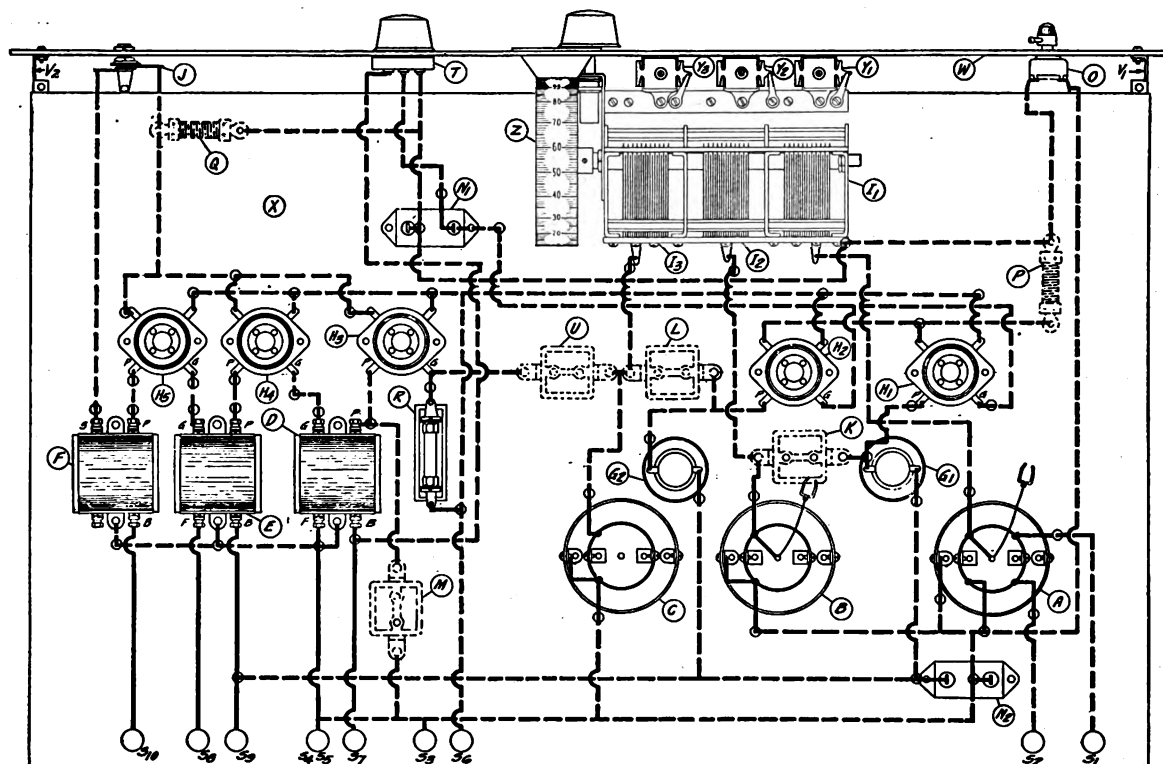
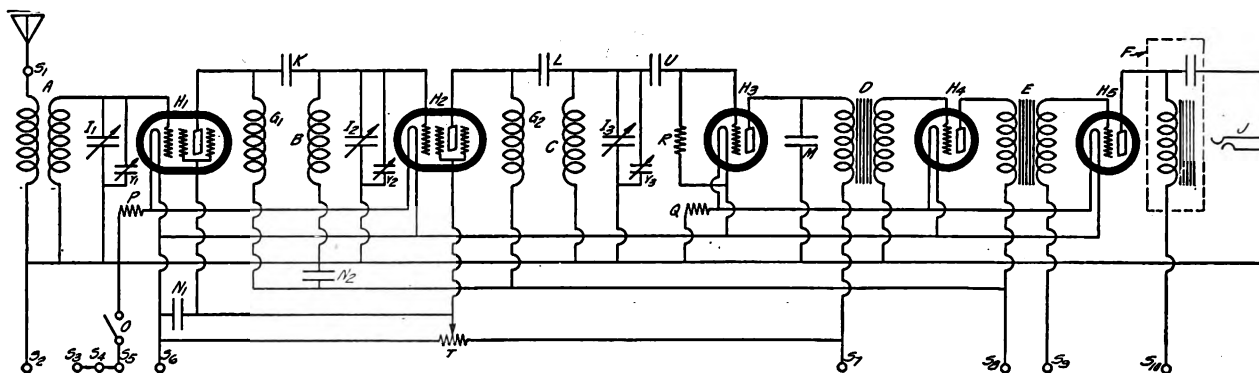


FIGURE 2: HOW TO WIRE THE RECEIVER



THE SCHEMATIC WIRING DIAGRAM

FIGURE 3: Note the impedance coupling employed in conjunction with the screen grid valves in the high-frequency amplifier. The low-frequency amplifier is of standard transformer-coupled design.

coupling. Figure 3 gives the circuit of the receiver.

Special aluminum shields are used to prevent magnetic coupling between the three tuned grid circuits, while other sources of undesired feed-back are eliminated by the use of the two $\frac{1}{2}$ mfd. condensers, N1 and N2.

There is the added advantage in this set of being able to use either batteries or socket power.

Assembly

Figure 1 shows the location of the various parts used in this set. The only parts under the sub-panel are the one-ohm and ten-ohm fixed resistances, Q and P, and the small fixed condensers. Most of these condensers are held in place by the wiring. The high-frequency coils, A and B, are mounted on top of

the sub-panel inside the shields. Lugs that are attached to these coils pass through holes in the sub-panel so that the wiring may be performed underneath. The second and third high-frequency coils are exactly alike. They have no primary winding and only two terminals each. The first high-frequency coil includes a primary winding and this coil has four terminals. A precaution should be noted at this point. Make sure to thread the flexible leads attached to the first and second coils through the holes in the tops of the shields, then solder the grid terminal clips to the ends of these two leads. The clips are connected to the control grid terminals of the screen grid valves of the set.

The picture wiring diagram, Figure 2, very clearly shows the necessary

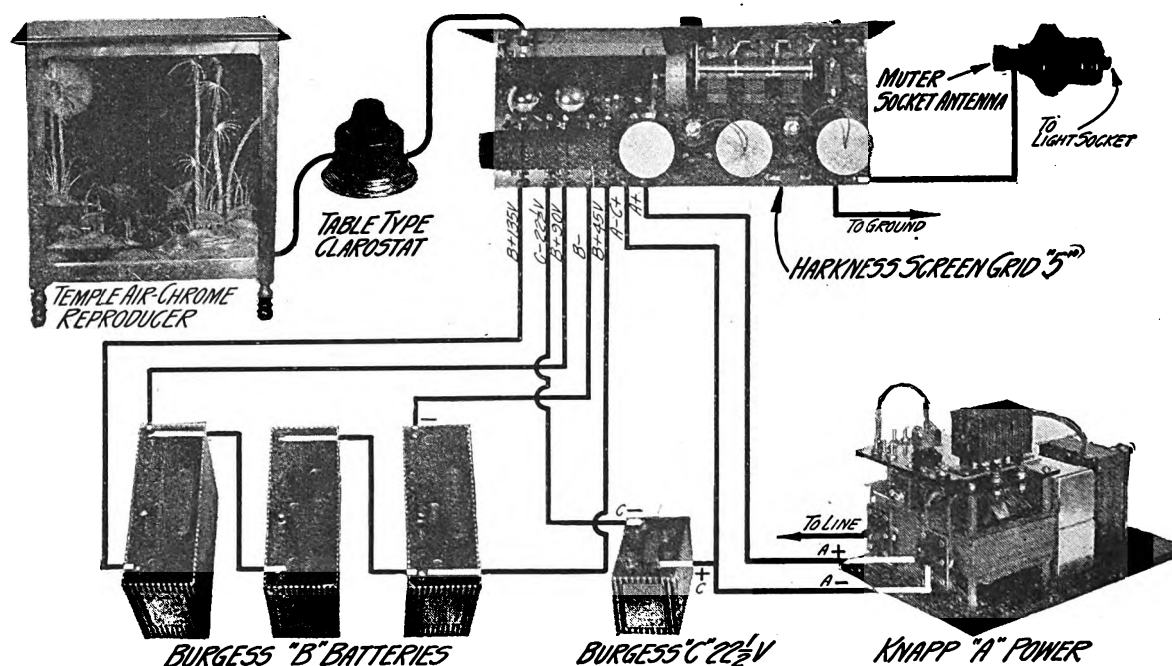
wiring and connections to the various terminals. This is not a lengthy procedure but care should be exercised in following the diagram exactly as shown. All wiring is shown in heavy black lines.

Hints on Operation

After the set has been completely wired it may be installed in a Corbett Cabinet, model C, 7 by 21 by 12 inches.

In the instance where "B" batteries are employed a 112 type valve should be used in the last stage of the receiver with a 12-volt "C" battery. If a 180-volt National "B" power-pack is used a Ceco J-71 tube may be used in the last stage with a 40-volt "C" battery.

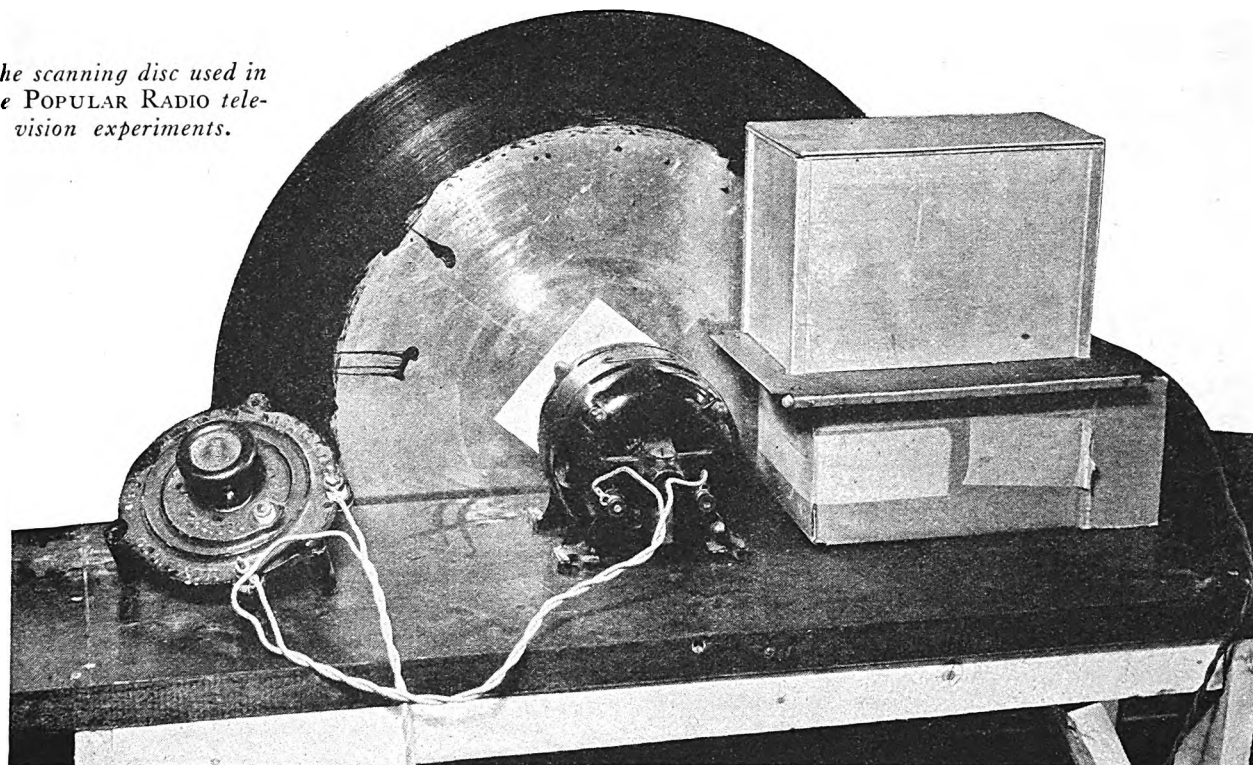
After the batteries or power-pack have been connected to the set and the proper connections made to the antenna (Continued on page 432)



THE OPERATING HOOK-UP

FIGURE 4: Note the table type Clarostat in this hook-up. By means of such a device the volume of the receiver may be controlled from a distance. The proper operating connections are shown in black lines.

The scanning disc used in the POPULAR RADIO television experiments.



SCANNING DEVICES

What They Do *and* How to Make Them

The scanning device may be considered the nerve center of any television system, for it acts as a means of directing and disposing of the light impulses that make up the transmitted image. With reasonable care the home experimenter may construct a simple scanning disc which will satisfy all the needs of home experiments in this fascinating new art.

By IRVIN HARRIS

THE scanning device is one of the key components of a television transmitter and receiver. Although simple and inexpensive to construct, it calls for a high degree of accuracy if distortion of the transmitter picture is to be minimized. It is the scanning device that causes the beam of light to explore the picture or object to be transmitted. This is done by a succession of holes which pass before the light source, each hole being so arranged as to cause the exploring beam to sweep across the object, each time at a lower level.

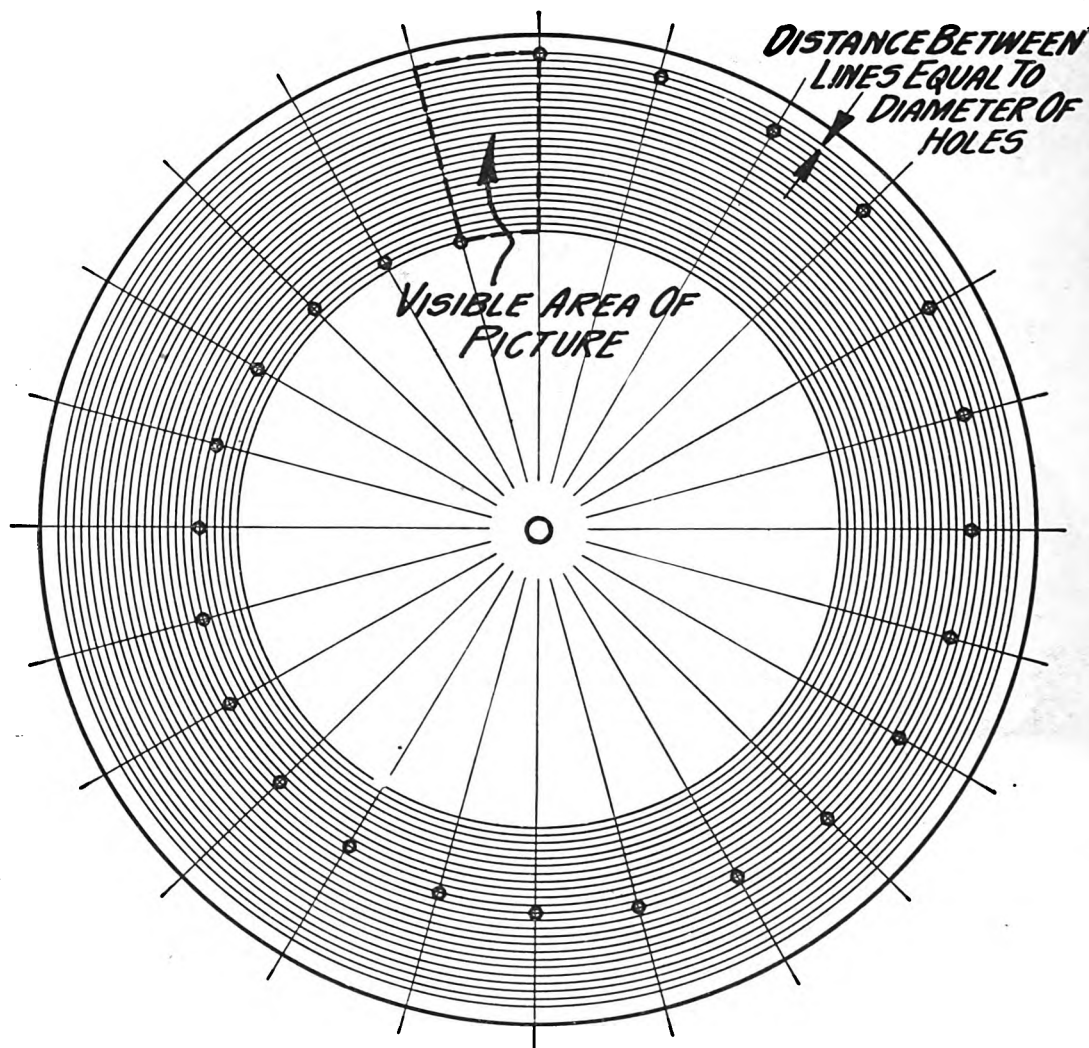
Although various types of scanning devices have been developed, the most simple one is that developed by Nipkow in 1884. Nipkow simply used a revolving metal disc with holes arranged in a spiral. Inasmuch as this spiral

must be accurately traced, if the exploring beam is to catch every detail of the object being transmitted, it behooves the experimenter to find some simple way of laying out the disc for the drilling operation. It is obvious that the average workshop is not equipped to trace these spirals with a machine method.

In Figure 1 there is shown a simple and very effective way of developing the spiral which will be sufficiently accurate for all amateur work. Having determined upon the diameter of the scanning disc used, the experimenter makes sure that the sheet metal that he is using is not perceptibly warped and that the exact center of the circle is found. Having done this, one line is drawn through the exact center of the disc. Next, a protractor is set so that

its central point rests on the center of the disc. For purposes of illustration, we shall assume that the scanning disc under discussion is to be provided with 36 holes, inasmuch as 36 is a divisor of 360, which is the number of degrees in a circle. This permits the holes to be laid out 10 degrees apart. In marking off the disc, care should be taken that the protractor will not move and, having assured himself of this, the experimenter may proceed by the aid of a sharp prick punch to mark the disc off. In doing this it will be found advisable to lay the disc on a solid metal surface, perfectly flat, so that there will be no danger of springing the metal under the impact of the hammer blows which, although light, may cause damage.

Having laid out the 36 holes, the workman proceeds to draw 36 lines so



HOW THE DISC IS LAID OUT

FIGURE 1: This drawing is diagrammatic only, and cannot be used for the exact layout of a disc. The visible area of the picture is defined by the radii through two consecutive holes and arcs of circles through the inner and outer holes. Hence, to make the area as nearly square as possible, a large disc should be used, with the arrangement of the holes near the edge of the disc.

that each line will go through the center of the disc and through each one of the prick punch markings. These markings should be made with a scribe and a straight edge, and patience and care should be exercised to make them as accurate as possible.

The next operation is that of drawing 36 concentric circles with a special compass sufficiently large to accommodate the work in hand. If this compass is not available in the workshop kit, a splendid substitute can be made readily with two wooden strips screwed together at one end so that they will move freely, the opposite ends each being provided with a phonograph needle. The outermost circle is drawn first, and the distance between this circle and subsequent circles will be determined by the size of the holes to be used in the scanning disc. This, as we shall see later, depends upon the demands to be made upon the apparatus, the degree

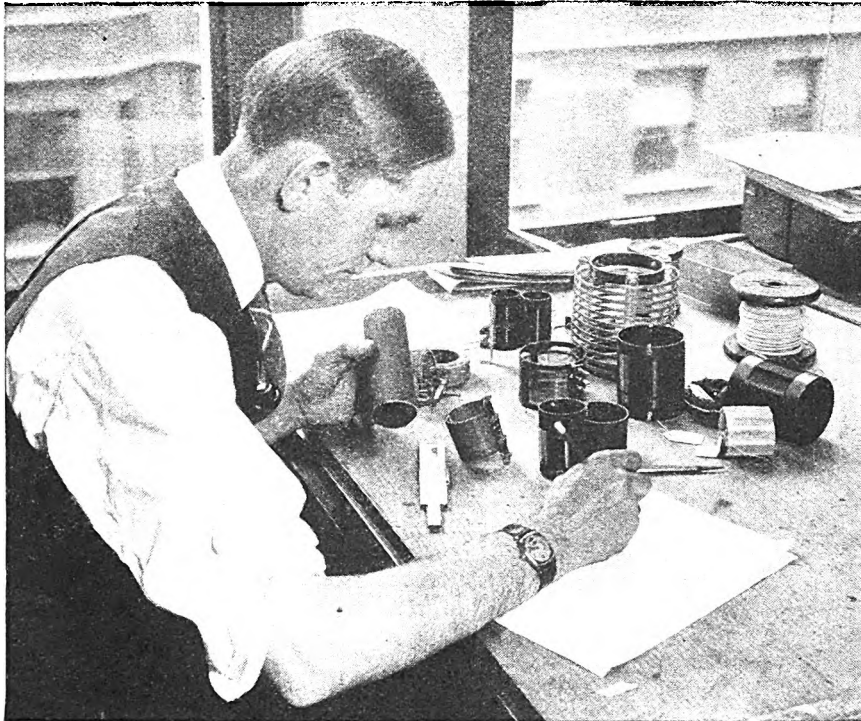
of quality desired, the speed of the disc, and the size of the picture to be handled. In this case, let us assume that a hole made by a No. 48 drill is chosen. A No. 48 drill has an actual diameter of .036 inch. It is this dimension that determines the distance between the concentric circles.

From a drawing in Figure 1 it is obvious that the matter of laying out the holes so that they will conform to a spiral is comparatively easy. The first hole is placed at any one of the indicated lines that were drawn. The next hole is placed on the intersection where the line of the second circle passes through the line indicating the next 10 degrees. The next hole is placed on the third line down, and so on, until the mark for the last hole is completed. Each hole should be carefully marked at the intersection line with a prick punch *before* the drilling operation is undertaken.

The drilling will have to be done with some care, for it is essential that the holes shall not overlap to any perceptible degree, although a trifle will not do any harm—in fact, it is beneficial. When the drilling has been completed, the holes are then lightly countersunk so as to effectively remove all burrs that may have been developed during the drilling. If the burrs are not removed the definition of the scanning beam will be partially destroyed and will lack the sharpness necessary for good reproduction.

Perhaps it might be advisable at this point to consider the various metals that are available for use in scanning discs. It is obvious that the metal must be thick enough to hold its shape, and that it will exhibit no tendency to warp. Aluminum, due to its light weight and its desirable physical properties, is perhaps the most acceptable of all the

(Continued on page 431)



PLANNING THE COIL

With a little skill, and the proper knowledge of coil construction outlined in this article, coils can be made at home that will satisfy all the needs of broadcast reception. Then, with the proper technique, the designing of special coils may be undertaken.

For the Amateur Designer of COILS

By EMIL REISMAN

IN spite of the fact that coil manufacturers have brought the making of coils to a high state of perfection, there are many set builders, both professional and amateur, who still prefer to wind their own coils.

A well designed coil must have a low DC resistance; it must have a very low self capacity; it must have a minimum of dielectric in its field; it must have a minimum of metal in its field; its insulation resistance must be high; and the relation between its length and diameter must be of the proper ratio.

The DC resistance of a coil is determined by the size of wire used in its construction. A wire too heavy leads to excessive eddy current losses. Therefore some of the smaller sizes of wire are to be preferred to the large sizes, even though their ohmic resistance is larger. In general, wire ranging from No. 18 to No. 26 is suitable for inductance coils.

The self capacity of a coil is a very important factor because coil capacity is a highly absorbing condenser. The

dielectric is the wire insulation and the material of the coil form. The self capacity of a coil adds greatly to its high-frequency resistance. A coil wound in the form of a solenoid with its turns slightly spaced has been found to have the lowest self capacity.

Any metal in the field of the coil introduces eddy current losses. Consequently, coils should not be mounted near or against metallic objects.

A high insulation resistance between the turns of the coil is essential or else much energy will be dissipated. The insulation of the wire and the form upon which the wire is wound should be of the best.

It has been found by the Bureau of Standards that in order to obtain the lowest possible high-frequency resistance and maximum inductance in a solenoid type of inductance coil, the coil should have such shape that the ratio

$$\frac{\text{diameter}}{\text{length}} = 2.46 \text{ approximately.}$$

The following is a formula whereby the inductance of a solenoid may be determined from its physical dimensions. Of course, when a certain inductance is wanted, the dimensions of the coil may be calculated from the formula by transposing the quantities.

$$L = \frac{.0395 a^2 n^2}{b} K$$

where L = inductance in microhenries.
 a = radius of the coil measured from the axis to the center of any wire.
 b = length of coil.
 n = number of turns.

The values of a and b are measured in centimeters. Inches may be converted to centimeters by multiplying by the constant 2.54. The value of K is a certain number which depends upon the ratio of the coil diameter to the coil length. The values of K have been calculated by H. Nagoaka and are given in the accompanying table.

<u>Diameter</u> <u>Length</u>	<u>K</u>	<u>Diameter</u> <u>Length</u>	<u>K</u>
.00	1.000	.95	.700
.05	.979	1.00	.688
.10	.959	1.10	.667
.15	.939	1.20	.648
.20	.920	1.40	.611
.25	.902	1.60	.580
.30	.884	1.80	.551
.35	.867	2.00	.526
.40	.850	2.50	.472
.45	.834	3.00	.429
.50	.818	3.50	.394
.55	.803	4.00	.365
.60	.789	4.50	.341
.65	.775	5.00	.320
.70	.761	6.00	.285
.75	.748	7.00	.258
.80	.735	8.00	.237
.85	.723	9.00	.219
.90	.711	10.00	.203

The natural wavelength of any coil and condenser in parallel may be determined by means of the following formula.

$$\lambda = 1884 \sqrt{LC}$$

where λ = wavelength in meters.

L = inductance in microhenries.

C = capacity in microfarads.

This formula may be used to determine the wavelength range of a coil and variable condenser if the minimum and maximum capacity of the condenser is known. If the inductance of the coil is not known, it may be calculated from the formula previously given.

Good coils, like good valves, are necessary for the satisfactory operation of any set. A set of poor coils in a receiving set may be the cause of broad tuning, interference, and poor volume.

Properly designed coils make for sensitivity, selectivity and quality.

POPULAR RADIO WORK SHEET

THE AC PR SHORT-WAVE CONVERTER

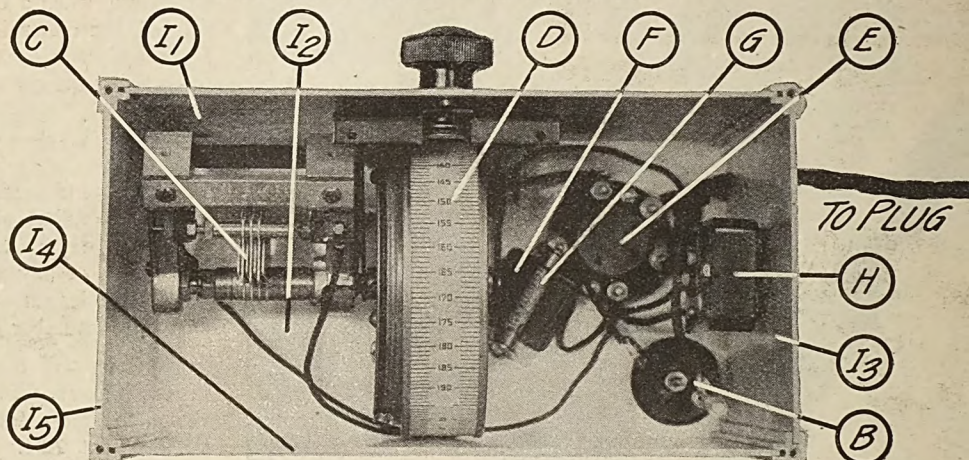


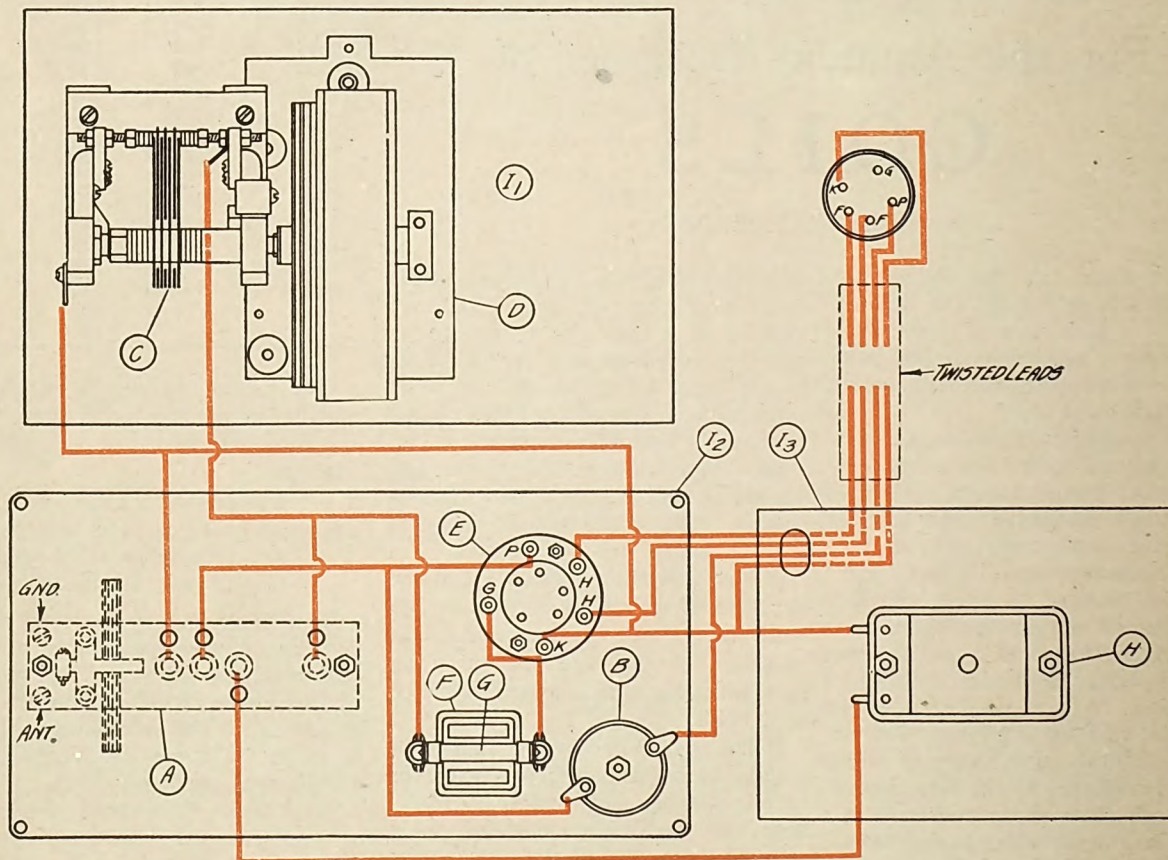
FIGURE 1: A VIEW FROM BENEATH

LIST OF PARTS USED IN BUILDING THIS UNIT

COST OF PARTS—Not over \$30.

A—Aero coil set, Type LWT-125;
 B—Aero choke, Type No. 60;
 C—National "Equitune" variable condenser, .00015 mfd.;
 D—National Velvet vernier drum dial, Type F;
 E—Benjamin 5-prong socket, No. 9036;
 F—Aerovox moulded condenser, with

clips for grid-leak mounting, .0001 mfd., Type No. 1475;
 G—Lynch resistor, 8 megohms;
 H—Samson neutralizing condenser, Type No. 61;
 I—Standard aluminum box shield, 5 by 9 by 6 inches high, made by the Aluminum Company of America.



HOW TO WIRE THE CONVERTER

FIGURE 2: The instruments inside the box shield are shown in solid black lines; those outside in dotted black lines. The wiring inside the shield is in solid red lines, and that outside in dotted red lines.



A Short-Wave Converter for AC Receivers

The success of the PR Short-wave Converter has been so great that the Laboratory staff has designed a new model, built on the same general lines, for use with socket operated sets. The new model is just as easy and inexpensive to build as the older one, and gives an equal order of excellence in operation.

By the TECHNICAL STAFF

THE PR Short-Wave Converter was designed so as to be easily adaptable to receivers using either DC valves or the new alternating current valves. Since the description of the PR Short-Wave DC Converter appeared in the April, 1928, issue of POPULAR RADIO, there have been many requests for information on an AC model short-wave converter.

The purpose of this article is to give the simple changes required to construct a short-wave AC converter. There are no batteries required for operating this unit. Reception on short-waves may be accomplished by simply inserting the connector plug in the detector socket of the AC receiver and connecting the antenna and ground leads to the converter as shown in Figure 3. All tuning is done with the new type vernier drum dial mounted on the front panel of the converter. The small knob on the right side of the unit controls regeneration.

The three interchangeable coils of the

coil set cover a range of from 15 to 130 meters. The smallest coil covers the band from 15 to 33 meters, the medium size coil covers a range from 31 to 68 meters, and the largest coil covers a range from approximately 57 to 133 meters.

The short-wave listener will find KDKA on 64 meters practically every evening during the week. Experimental programs are broadcast by WGY on waves between 15 and 105 meters. Station 2YT, at Poldhu, Ireland, carries on experimental work on about 94 meters and Station G2NM at London, England, may be heard most nights after 11 P. M. Central Standard Time, on about 44 meters.

This simple and inexpensive addition to your present receiver will open up a new field of reception which will prove a revelation to the broadcast listener.

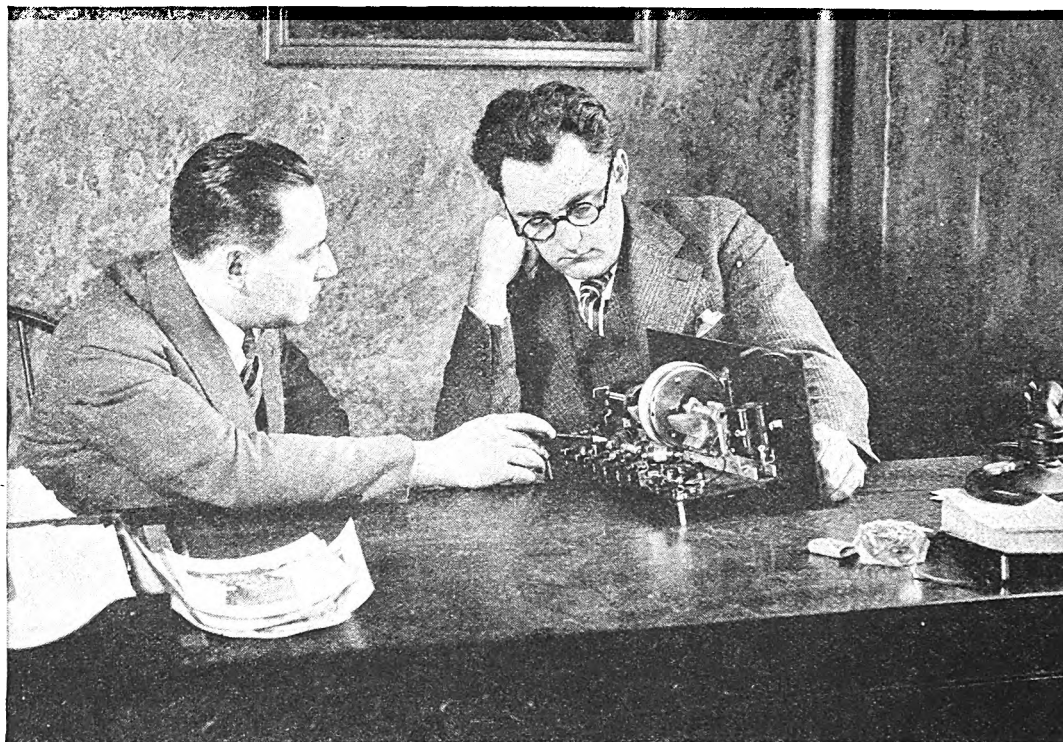
The Construction of the PR Short-Wave AC Converter

In building the AC Converter the

same general construction details should be followed as were outlined for the DC Short-Wave Converter in the April, 1928, issue of POPULAR RADIO.

By referring to Figure 2, it will be noted that the five-prong socket, E, is used in place of the standard four-prong socket. Another replacement is the connector plug made from the base of a burnt out UY-227 type valve. After the glass and other matter is removed from the base, solder the two heater leads, the plate lead and the cathode lead to their respective prongs of this five-prong base. The two heater leads should be twisted and then all four leads twisted together.

As in the previous converter, all parts are enclosed within the standard aluminum box shield, I, excepting the coil assembly, A, which is mounted on top. The drilling plan of the top panel, for mounting coil assembly A, socket E and choke coil, B, is shown in Figure 4. The neutralizing condenser, H, is
(Continued on page 426)



THE FINE POINTS OF THE NATIONAL

The simplicity of the National tuner is evident in this picture. The feature of most interest to the novice at set construction is the tuning unit, which may be procured already assembled and ready for mounting.

Efficiency! Low Cost! Simplicity!

The National Screen Grid Tuner

The National tuner recommends itself to fans of limited means who want the best for their money; for although it embodies a circuit of proved excellence, and makes use of the new screen grid valve, it is inexpensive and quite easy to assemble, and operate.

By VICTOR O'BRIEN

TO the home constructor of modest means and with an appreciation of tonal quality the new screen grid National tuner has an especial appeal. It is easily constructed and has a neat appearance that is comparable with many higher-priced radio sets. One of the outstanding features of this receiver is the aluminum chassis construction for the two coils, two condensers and drum dial which is the nucleus of this receiver. This arrangement simplifies construction, saves time and assures one of the proper placement of parts.

Simplicity is also exemplified in this compact radio set to a remarkable degree. An engraved illuminated drum dial with the attendant escutcheon plate is an example of simple and beautiful design. The unique method of eliminating lost motion in the drum dial shows

clearly the thought expended in making this item one of the best that has been called to the writer's attention.

The use of a screen grid valve in the high-frequency portion of the set with the attendant efficient coil and condenser assures the builder of a high degree of amplification.

How to Assemble the Tuner

The panel and sub-panel are drilled and ready for the mounting of the various units. The single control tuning unit, which comprises two coils, two condensers and the drum dial, A, B, C, D and E, in Figures 1 and 2, comes from the factory as a unit and necessitates only the removal of the escutcheon plate and knob prior to its installation on the sub-panel.

Four screws fasten this unit securely

to the sub-panel by means of the condenser frames. It will be noted that three of the four screws have lugs beneath the screw heads. Figure 2 shows how two screws will fasten the dial frame to the panel. Next mount the General Radio sockets, F1 and F2, with the grid and plate terminals toward the single control tuning unit. The Lynch single mountings, which will contain the high-frequency choke coils, G1 and G2, may be installed next. After this the Lynch double mounting, N-O, may be centrally located and fastened down. Following this the grid-leak holder, M, should be fastened in position.

The binding posts, R1 to R8, should then be placed in position with the lugs. The grid condenser, J, may now be fastened securely by means of a screw

POPULAR RADIO WORK SHEET

THE NATIONAL SCREEN GRID TUNER

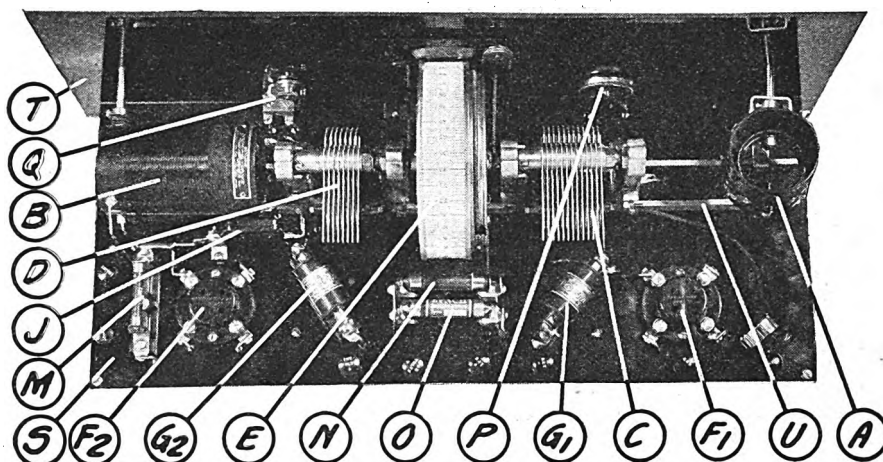


FIGURE 1: THE TOP VIEW

LIST OF PARTS USED IN BUILDING THIS RECEIVER.

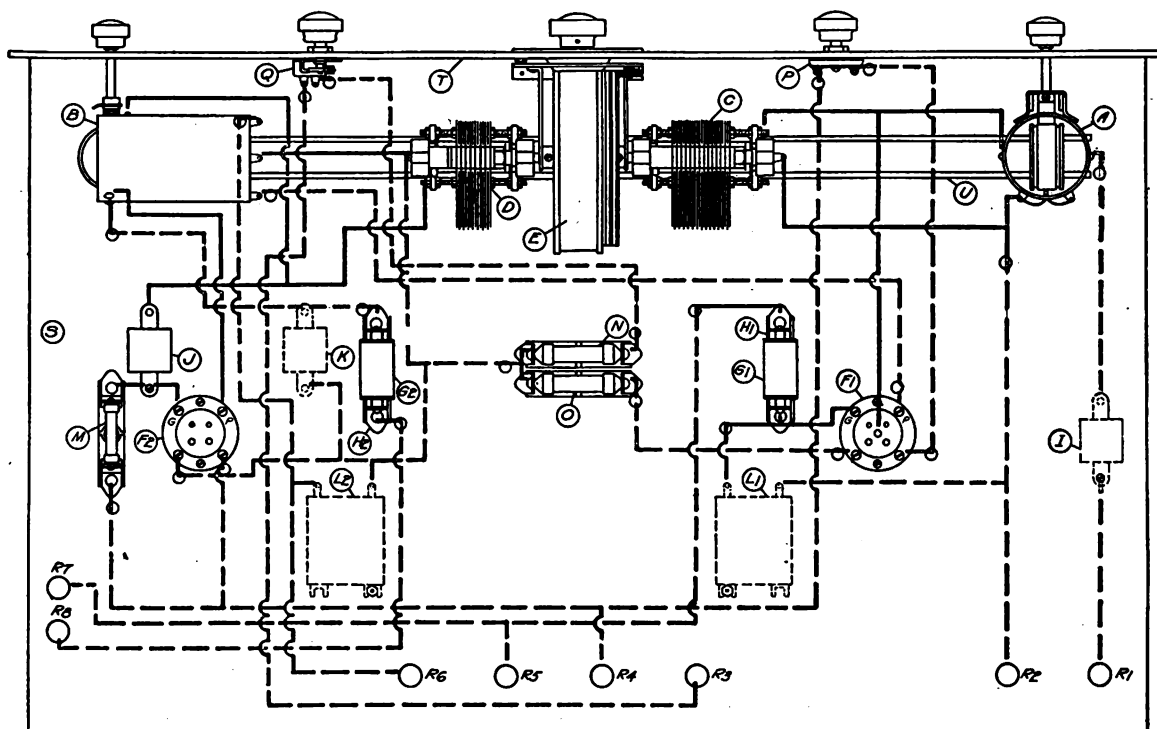
COST OF PARTS—Not over \$47.00

National single control tuning unit for screen grid valves containing:

- A—National screen grid antenna coupler;
- B—National Regenaformer;
- C—National "Equitune" variable condenser, .0005 mfd.;
- D—National "Equitune" variable condenser, .00035 mfd.;
- E—National Velvet Vernier Drum dial, type F—with type No. 28 Illuminator;
- U—Metal chassis for supporting the above parts;

- F1 and F2—General Radio sockets, type 349;
- G1 and G2—National high-frequency chokes;
- H1 and H2—Lynch Equalizer mountings;
- I—Aerovox moulded condenser, .0001 mfd.;
- J—Aerovox moulded condenser, .00025 mfd.;
- K—Aerovox moulded condenser, .001 mfd.;
- L1 and L2—Aerovox filter condensers, 1 mfd., type 200;

- M—Lynch grid-leak, 2 megohms, with grid-leak mounting;
- N—Lynch Equalizer, type 4/5, with mounting;
- O—Lynch Equalizer, type 15, with mounting;
- P—Carter Midget rheostat, 20 ohms, type M-20;
- Q—Yaxley battery switch No. 10;
- R1 to R8—Binding posts;
- S—Composition drilled sub-panel, 17 by 7 by 3/16th inch;
- T—Composition drilled front panel, 18 by 7 by 3/16th inch.



HOW TO WIRE THE SET

FIGURE 2: Dotted RED lines indicate wiring under the sub-panel; solid RED lines wiring above the sub-panel.

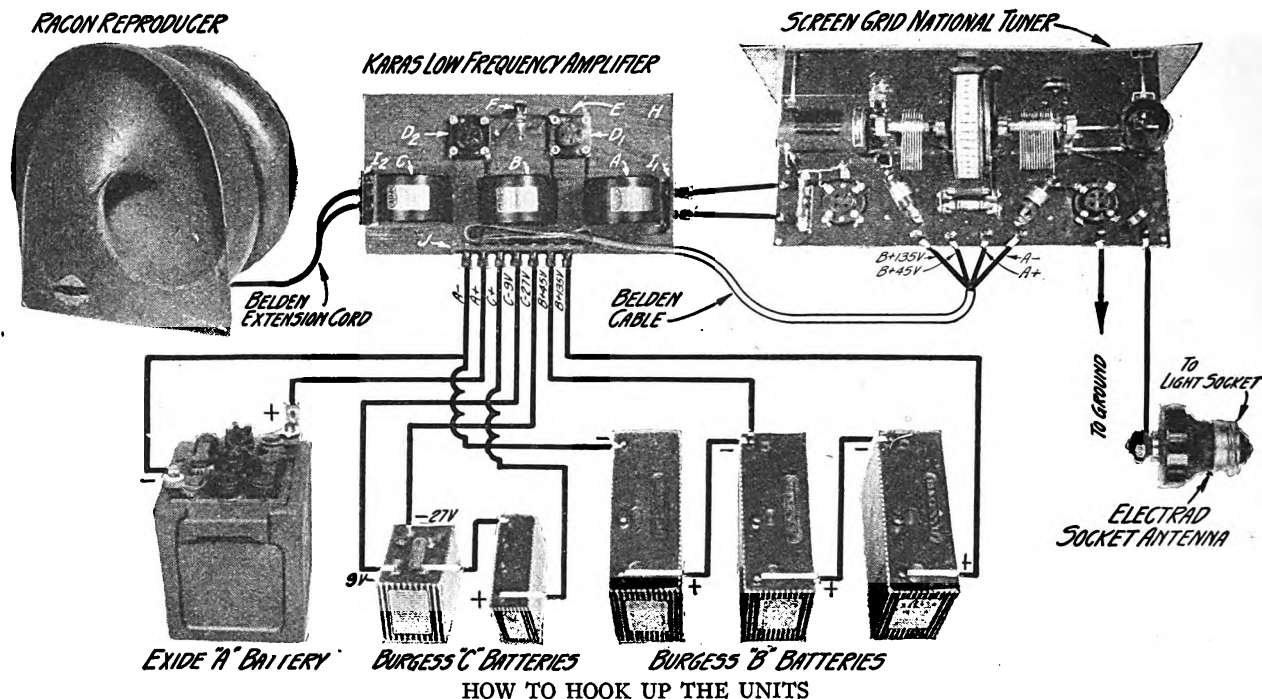


FIGURE 3: The Karas low-frequency amplifier, which is recommended for use with the National tuner, is described in this article. Its construction is quite clear from the data given in the text and in this diagram and Figure 5.

and nut to the aluminum bracket and this bracket fastened to sub-panel as shown in Figure 2.

Referring to Figure 2, we find beneath the sub-panel two 1 mfd. condensers L1 and L2, which are mounted using one screw each and with the terminals toward the single control tuning unit. The .0001 mfd. condenser, I, is next mounted, with lug. The two rear corner supports should then be fastened beneath the sub-panel. This completes the sub-panel assembly.

The front panel has a Carter rheostat mounted about five inches from the left edge of panel. A Carter switch is located and mounted a like distance from the right-hand edge of panel.

The front panel may now be put in position, fastened to the sub-panel by

means of the three screws which go through the escutcheon plate, front panel and thread into the drum dial support.

The five knobs should now be placed in position. This completes the assembly, with the exception of the .001 moulded condenser, K.

The picture wiring diagram, Figure 2, clearly shows the proper placement of wires and connections to the various instruments.

The Karas Amplifier

The Karas low-frequency amplifier has been chosen as fitting companion to the National tuner, as it provides more than sufficient volume for the average home with extremely good quality. The output transformer permits of a power valve being used without endangering the loudspeaker.

The baseboard may first be stained and permitted to dry; then the Karas transformer, two Benjamin sockets, switch and three binding post strips may be mounted in position. A reference to Figure 3 shows this clearly.

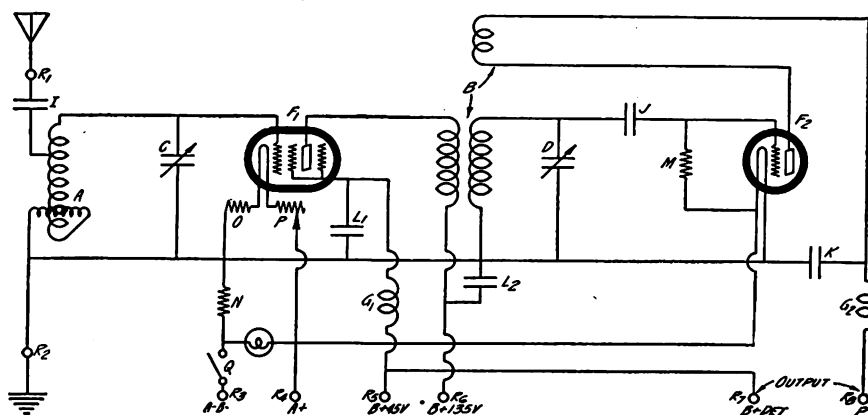
The wiring of this unit is simplicity itself and is clearly shown in the schematic diagram in Figure 5. The parts necessary are listed here:

- A and B—Karas low-frequency transformers, type 28;
- C—Karas output filter;
- D1 and D2—Benjamin Cle-ra-tone sockets, type 9040;
- E—Yaxley resistance unit, 2 ohms, type 802;
- F—Benjamin battery switch, type 8640;
- G1 to G9—Binding posts;
- G10 and G11—Yaxley phone tip jacks, No. 422;
- H—Hardwood baseboard, 14 by 7½ by ½ inch;
- J—Bakelite binding post strip, 6 by 1 by 3/16 inch;
- I1 and I2—Bakelite binding post strips 2½ by 1 by 3/16 inch.

How to Operate the Units

To the left of the National screen grid tuner will be noted a small coil that rotates within a larger coil. This piece of mechanism is designed to compensate for the various differences in antennae and to permit more readily of accurate tuning by means of the National drum dial. The knob at the extreme right controls the feed-back to the detector valve. This in practice tends to tune the detector plate circuit, which sharpens tuning to a considerable

(Continued on page 423)



THE CIRCUIT OF THE TUNER

FIGURE 4: Regeneration is employed to a limited extent, and is controlled by varying the coupling in the coil, B.



IN THE WORLD'S LABORATORIES

Cathode Ray Television

THERE are many thoughtful research workers who insist that the present methods used in television are impractical and that the limit of perfection has, for the moment, been reached. These men do not mean to infer that television is utterly impossible, but they maintain that we have started off with the wrong foot, and that the apparatus we are at present employing in the scanning process is inadequate.

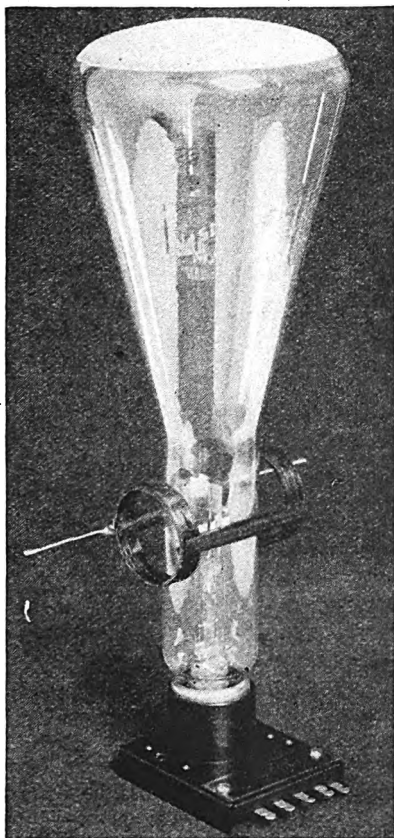
Actual results obtained, however, do not bear this opinion out, for amazingly perfect living pictures have been successfully transmitted with the very apparatus that has been condemned.

At the present time a revolving disc with spirally arranged holes is used to

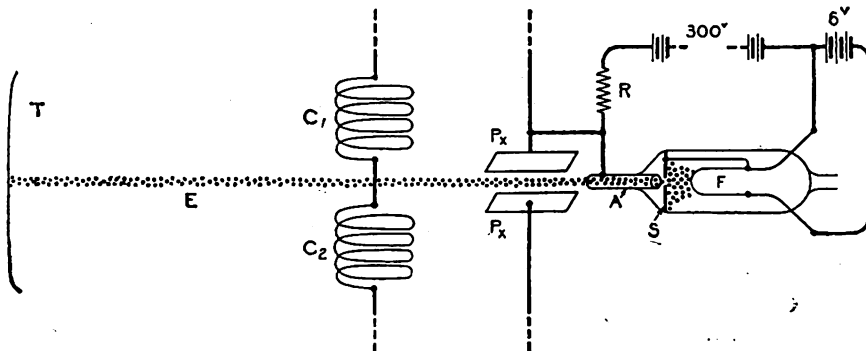
scan the pictures to be transmitted. Some who have gone into the mathematics of the problem claim that only the simplest arithmetic is necessary to show the utter impossibility of carrying this system to ultimate perfection. Dreadful numbers are encountered that make even the most optimistic of investigators feel more than a little hopeless. The critics of the present system base their conclusions on the problem of projecting at the receiver a television image ten centimeters square—a rather small picture. If one divides each side of the square by a hundred, the picture is divided in 10,000 small squares; and, incidentally, squares of a millimeter do not make up a very fine picture. Each one of these small squares has to be "seen" by the electric eye, and, to give a fair appearance of continuous movement to the picture,

A CATHODE RAY OSCILLOGRAPH TUBE

Although the cathode ray tube shown at the left is used to produce visible effects on a fluorescent screen, this same type of tube is being used by Dr. Dieckmann in his experiments in television, using cathode rays that are subject to the influence of magnetic and electrostatic effects.



Bell Telephone Laboratories, Inc.



HOW THE CATHODE RAY METHOD WORKS

Dr. Dieckmann uses a cathode ray tube in his television work that operates on a principle similar to the cathode ray oscillograph tube developed sometime ago by the Bell Telephone Laboratories. In the oscillograph tube electrons are produced at the filament, F, and pass through the charged metal tube, A, in the form of a thin pencil. This stream may be deflected from its normal path by electrostatic stress at P or by the magnetic field at C1 and C2.

the whole has to be transmitted and flashed on the receiving screen about ten times a second. This points to the necessity of flashing 100,000 squares of light every second, and the number that is necessary to make a good moving picture is 300,000 flashes a second.

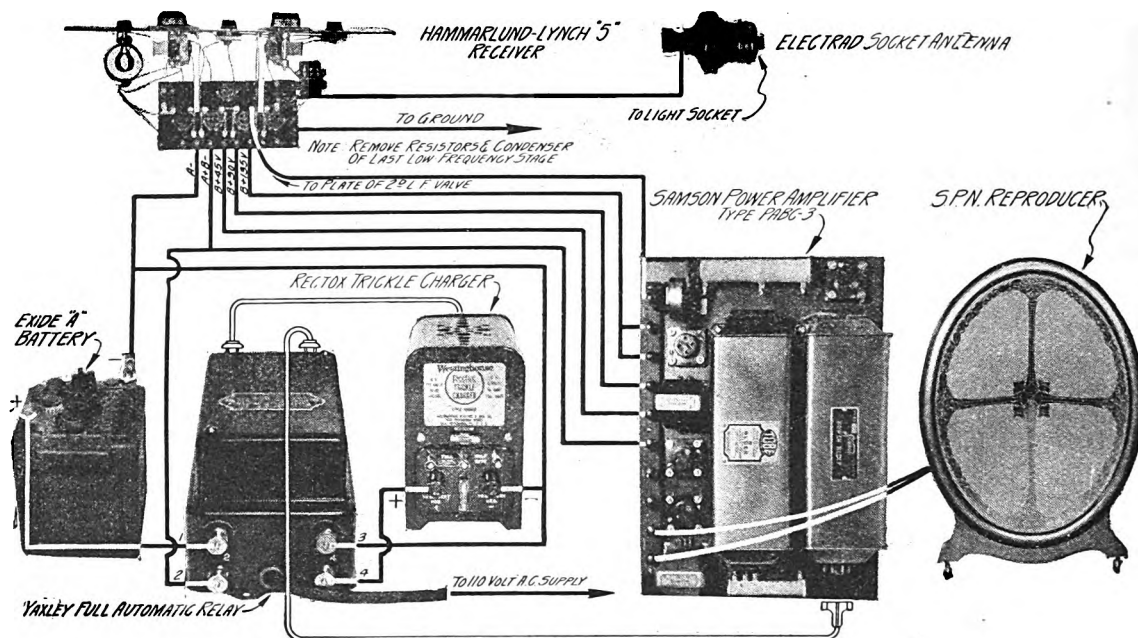
Those who have had the opportunity of viewing television reception have noticed that fast movement of the object produces a blur at the receiving screen. The photoelectric cell is blind to movements that exceed certain speeds.

Professor Max Dieckmann, the German investigator, realizing the inherent weaknesses of the present efforts to obtain perfect television, has launched into a new series of experiments with the object of employing cathode rays at the receiver. It is known that cathode rays are sensitive to even very weak magnetic fields, and that the paths of the rays are easily bent out of their normal path by small magnetic disturbances. Although Professor Dieckmann has had some success with the reproduction of pictures by the use of this method, he still has before him the problem of employing cathode rays in the transmitting equipment.

In applying cathode rays to scan an object to be transmitted, Professor Dieckmann is experimenting with electromagnets, one of which is used to draw the rays laterally, and the other, placed at right angles, to draw them vertical. Alternating currents are used to energize one magnet twenty times as frequently as the other, so as to make the rays zigzag over the object.

In the receiver that Dr. Dieckmann has developed he works on the same principle, using cathode rays, regulated according to the strength of the radio impulse received. These are made to zigzag over a fluorescent screen which glows under the action of the impinging

(Continued on page 406)



HOW THE UNITS ARE HOOKED UP

FIGURE 1: The Hammarlund-Lynch "S" is shown here as an example of broadcast receivers that may be used with the Samson power-pack amplifier. The connections to the "A" current supply, reproducer and antenna are also shown in black lines.

A New Way to Quality Reproduction With the Samson Amplifier

The power-pack amplifier whose construction is described in this article furnishes the set builder and fan with an ideal method of bringing his old receiver up to date by the addition of a push-pull low-frequency stage of 371 type valves. In addition, the unit furnishes all the necessary "B" and "C" voltages for the ordinary broadcast receiver. And in construction it is one of the simplest units ever designed.

By CARL DORF

IN these days the art of power amplification has been reduced to such a simple and efficient formula that there is no reason why any old model receiver should not be brought up to date so that it will furnish excellent power and tone quality in its reproduction. A new power-pack amplifier recently developed by the Samson engineers contains all of the latest developments in power amplification. It can be built by any radio fan or professional set builder and installed in a short time as the power stage of any receiver. It will furnish complete "B" and "C" power for the receiver used with it at the various voltages required.

It also contains a stage of efficient push-pull amplification working into

two 371 type power valves. A voltage regulator valve is utilized to keep the "B" voltages constant no matter how much the AC line voltage surges or varies. This is a very important consideration in light-socket operation.

The complete amplifier is pictured in Figure 2, and it will be noticed that it contains the necessary power block consisting of a power transformer and the choke coils for the filter, and a complete filter-capacity block, in the same uniform type of housing, together with the necessary voltage-dividing resistors and sockets accommodating the rectifier valve, the regulator valve, and the two push-pull amplifier valves. A connection strip runs along one side from which the various "B" and "C" voltages

for running the set may be taken off.

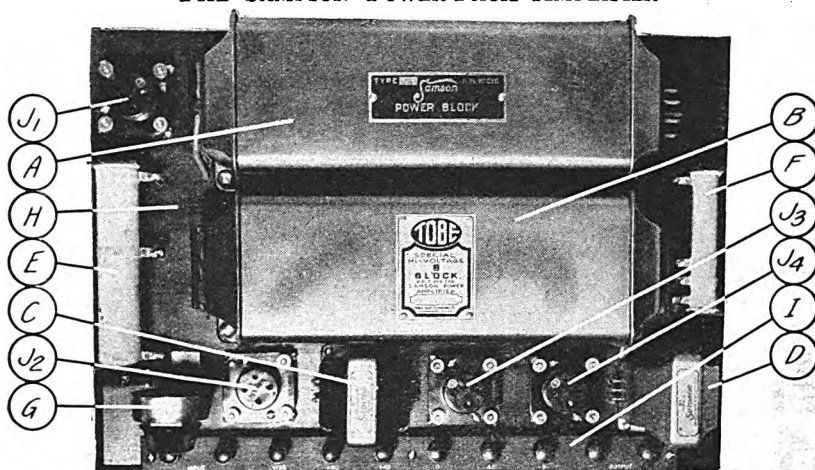
The amplifier may be used in conjunction with any receiver as the last stage of amplification. It does not matter whether the receiver itself incorporates resistance coupling, transformer coupling, impedance coupling or any combination of these. All that is necessary is to disconnect the last stage of amplification in the receiver and use the new power-pack amplifier connected to the receiver at the plate circuit of the amplifier valve that precedes the last stage.

One of these new units connected to a receiver will greatly improve its reception qualities both as to sensitivity (due to having at all times the correct

(Continued on page 430)

POPULAR RADIO WORK SHEET

THE SAMPSON POWER-PACK AMPLIFIER



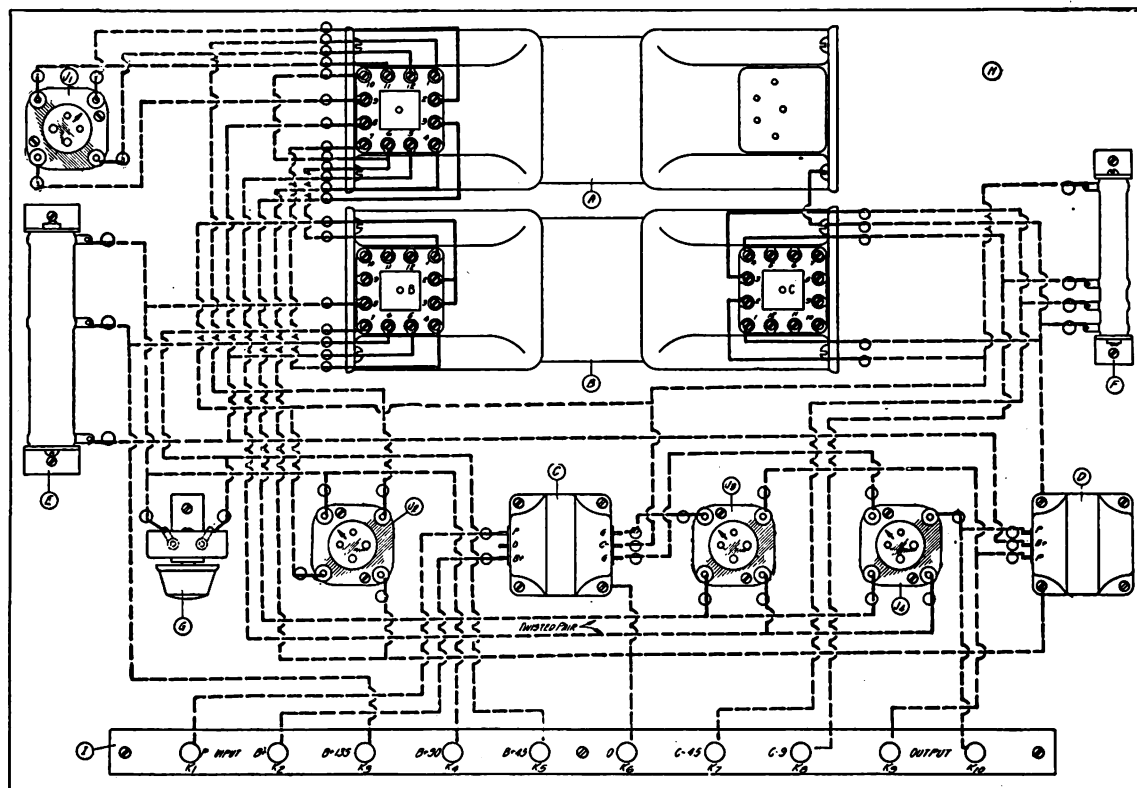
THE UNIT FROM ABOVE

FIGURE 2: All the parts are mounted above the panel, and are clearly shown in this view of the unit.

LIST OF PARTS USED IN BUILDING THIS UNIT

COST OF PARTS—Not over \$90.00

- | | |
|---|---|
| <p>A—Samson power block, type No. 718;
 B—Tobe BC condenser block, No. 718;
 C—Samson push-pull input transformer, type Y;
 D—Samson push-pull output impedance, type Z;
 E—Lynch tapped resistor, 2,850 ohms, type No. SE-28;
 F—Lynch tapped resistor, 570 ohms, type No. SE-5;</p> | <p>G—Frost variable resistor, 0 to 50,000 ohms, type No. 880;
 H—Baseboard, 12 by 17 by $\frac{3}{4}$ inch;
 I—Micarta binding post strip, 1 by 14 by $\frac{3}{16}$ inch;
 J1 to J4—Benjamin Cle-ra-tone sockets, No. 9040;
 K1 to K10—Eby binding posts;
 Gavitt rubber-covered hook-up wire, solder, screws, rubber feet, etc.</p> |
|---|---|



HOW TO WIRE THE UNIT

FIGURE 3: By mounting the baseboard on rubber feet, much of the wiring may be done under the baseboard, as indicated here in dotted RED lines. Solid RED lines show wiring above the baseboard.



In the Professional Set Builder's Shop

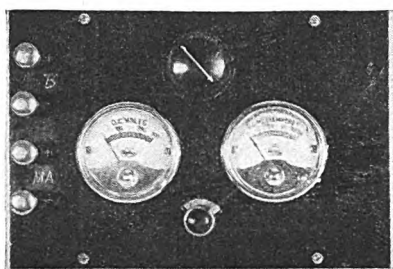
Practical pointers and kinks to increase the efficiency and earning power of those who construct, repair or service receivers for profit. If there is a better and easier way to do it, this department of POPULAR RADIO, aided by a well-equipped Laboratory, will find it and present the details here to our readers in a practical and concise manner.

An Inexpensive "B" Eliminator Tester

THE service kit for the repair of radio receivers cannot be complete unless it includes a "B" eliminator tester. Ordinary low-resistance voltmeters cannot be applied to this work, since the meter itself draws sufficient current to render accurate readings impossible. This eliminator tester uses a high-resistance voltmeter in combination with a milliammeter of suitable range. Both instruments are inexpensive and accurate enough for all practical purposes in radio testing work.

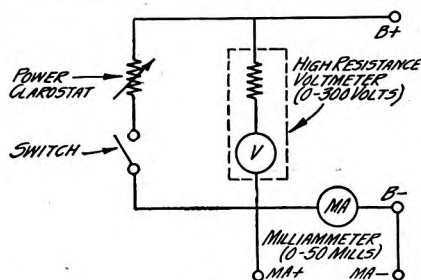
This "B" eliminator tester requires the following parts:

- 1 Sterling 0-50 milliammeter, type R-1626;
- 1 Sterling high-resistance voltmeter, 0-300 volts, with external resistor;
- 1 Power Clarostat;
- 4 XL binding posts;



THE PANEL OF THE UNIT

FIGURE 2: The voltmeter is at the left and the milliammeter at the right. The binding posts are, from top to bottom, "B+," "B-," "MA+" and "MA-."



THE CIRCUIT OF THE TESTER

FIGURE 1: The wiring of the instrument is clearly shown in this diagram; all the wires are run under the panel.

- 1 Composition panel, 6 by 8 by $\frac{1}{4}$ inch thick;
- 1 Carter "Imp" switch.

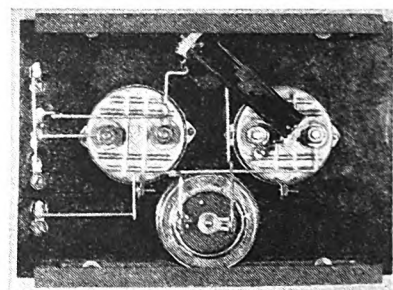
Figure 1 shows the connections schematically. Figures 2 and 3 show the unit from above and below. This device will measure the output of any "B" eliminator having a maximum load of 50 milliamperes and 300 volts. This is done by connecting the output of the "B" eliminator to the binding posts marked "B+" and "B-." The output load on the eliminator may be measured without load by turning the Carter "Imp" switch to the "off" position. By switching over to the "on" position the Clarostat is put into the circuit, and any load may be placed upon the "B" eliminator, the resulting meter indications showing it. The artificial load is placed upon the "B" eliminator by turning the Clarostat knob, which either increases or decreases the resistance. The amount of the load is shown by the milliammeter. If, for instance, the set which is being checked up draws a total

of 35 milliamperes, the Clarostat may be adjusted so that the milliammeter will read this figure. A glance at the voltmeter will show the amount of voltage delivered at that current value.

This device can also serve as a separate "B" voltmeter by simply applying the voltage source to the "B" binding post and turning the switch to the "off" position. A separate current reading may also be obtained by connecting the supply to the binding post marked "MA+" and "MA-." This separate milliammeter load may be very helpful in determining exactly what any set draws. It is only necessary to disconnect the "B-" terminal of the set being tested and attach it to the "MA-" post on the milliammeter. The "MA+" post should now be connected to the point where the "B-" lead to the set was removed. This will complete the circuit and give the current reading.

—MARTIN ZEVIN SILVER

(Continued on page 412)



THE UNDER SIDE OF THE PANEL

FIGURE 3: Note the wooden strips at the top and bottom which support the panel and keep the instruments clear.



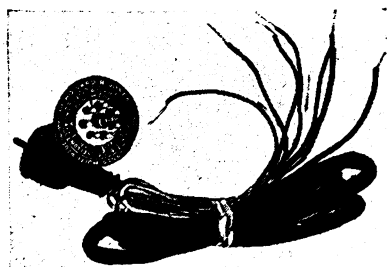
BIGGER AND BETTER EVERY YEAR

The man at the left is holding a 10,000-watt Mazda light, the latest innovation in motion picture lighting. At the right is one of the new 5,000-watt power valves of the type used in all the latest Western Electric transmitters.

What's New *in* Radio

Conducted by
THE TECHNICAL STAFF

The material listed in these columns has been carefully tested in the POPULAR RADIO Laboratory, which is acknowledged to be one of the most completely equipped institutions of its kind. Mention in the following pages signifies that the apparatus illustrated has met the approval of the POPULAR RADIO Engineering Staff.



An Inexpensive Cable Connector Cord

Name of instrument: Connector cable.

Description: Although this particular cable was made with seven connections, G, A, "A" battery +, B+ amplifier, B+ Detector, B-, A-, this type is available with as many as twelve connectors. The plug comes with a soft rubber covering. The connectors, which are of the spring type, are mounted in a molded Bakelite

piece in which the seven-cord cable terminates. The plug engages with a receptacle having seven corresponding soldering lugs, which are marked with a color of the corresponding wire. A printed cardboard disc is used as a guide to the proper connections. The cable, from the adapter to the tip of the connecting wires, measures 48 inches, and each connecting wire is encased in a soft rubber insulation, the bare ends being solder-tipped.

Outstanding features: Simplified construction.

Maker: Howard B. Jones.

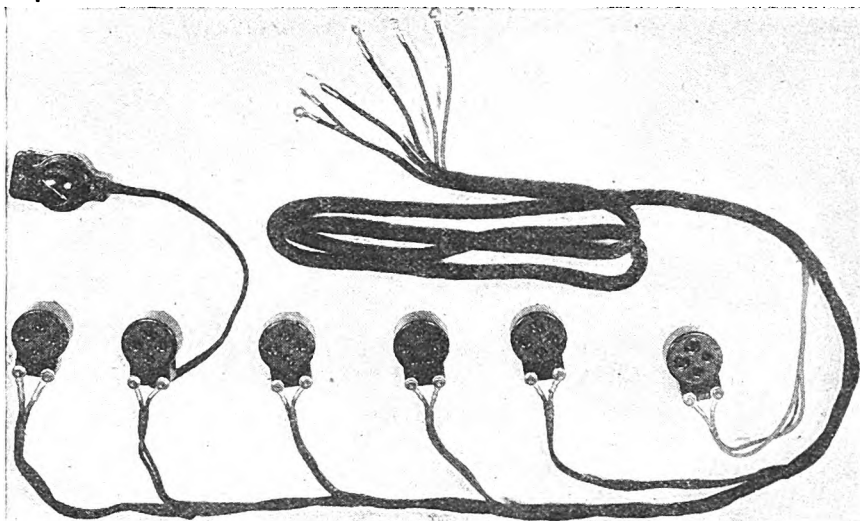
Chemical Condensers for Filter Condenser Work

Name of instrument: Electrolytic condenser.

Description: This electrolytic condenser is mounted in a copper can $4\frac{3}{4}$ inches high and 3 inches in diameter. The



top is of Bakelite sealed into the can with a rubber washer which effectively prevents any leakage of the contents. It also prevents seeping and corrosion. Two terminals from two electrodes are brought out through the Bakelite top and each is provided with a soldering lug. In use the can, or container, is made negative. The condensers are made in various capacities; the one tested had a total capacity of 50 mfd., or 25



mfd. per anode. The peak operating voltage is 450, and the maximum operating voltage for continual service 300. The condenser is self-healing and may be employed for filtering purpose in "B" eliminators and power amplifiers.

Outstanding features: Leakage-proof electrolytic condenser of high capacity, occupying small space.

Maker: Amrad Corporation.

Quick Changes to AC

Name of instrument: AC harness with sockets.

Description: This harness, which is provided with heavy connecting wires of various colors, is provided with six adapters—four to accommodate 226 type valves, one for the 227 type valve, and one for the 171 type valve,

providing the user desires to put such a valve in the last stage. Otherwise this socket may be used for a 226 type valve. The adapters are well made of moulded Bakelite and each one is provided with large connectors for holding the lugs of the harness securely by means of a 6/32 machine nut. The connecting wires, which are large and flexible, are each provided with lugs that may be readily attached to the transformer. Each harness comes provided with a volume control, mounted in a moulded Bakelite container.

Outstanding features: Liberally designed cords and moulded Bakelite adapters provide for the quick, easy changing of the ordinary receiver to AC operation.

Maker: Enterprise Manufacturing Company.



Current Supply for AC Vales

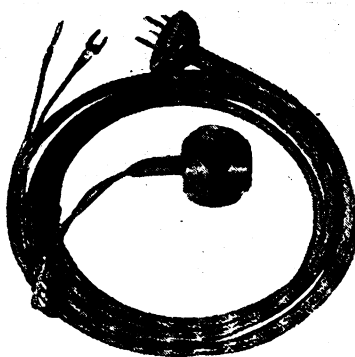
Name of instrument: Filament transformer.

Description: This transformer, which is enclosed in a black Japanned case measuring 6½ by 3¼ by 5½ inches, provides three standard voltages, for the 226, 227, and 171 type valves. This corresponds to voltage outputs of 1½, 2½ and 5. The terminal block is placed under the cover of the transformer, which also has a hole large enough to provide for incoming connections. The cover is easily removed

to facilitate connecting. A large, heavy, rubber-insulated connecting cord with a plug is provided with each transformer. The terminal block previously referred to also has a ground connector and a post for the "B" 45-volt connection.

Outstanding features: Compactness. Conservative engineering design.

Makers: Enterprise Manufacturing Company.



Aerial and Power Service Cord All in One

Name of instrument: Service cord provided with socket antenna.

Description: This service cord, which provides for the connection to the "B" eliminator and "A" eliminator or other power device, also incorporates a socket antenna. The leads for the antenna are brought out on two different colors, each provided with a connecting lug. By utilizing the capacity between the two rubber-covered cords a convenient type of indoor antenna is provided. In actual use it is found that one terminal might give better results than the other, owing to a difference in capacity. The cord provided with the equipment is 9 feet long.

Outstanding features: Incorporation of service extension cord and light-socket antenna in one cable.

Maker: Tidmarsh's Radio Supply Company.



Large Capacity in a Small Space

Name of instrument: Dry "A" condenser.

Description: Although this condenser measures only 7 by 2 by 2 inches, it houses a capacity of 2,000 mids. Its elements are made up of a very special preparation which allows large working capacity to be incorporated in a small container. The case is finished in aluminum paint, and the terminal are brought out through Bakelite insulators at the top. The condenser shows no polarizing tendencies and may be connected into any "A" battery eliminator circuit. But once connected, the terminals should never be reversed. The user of this condenser is cautioned not to employ it for voltages much above six, if it is to be placed in continuous operation. Due to its extremely high capacity, its use in filtering out the hum of "A" battery eliminators is highly recommended.

Outstanding features: Large capacity in small space.

Maker: Aerovox Wireless Corporation.



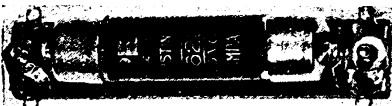
All AC Filament Voltages Obtained from This Unit

Name of instrument: "A" power transformer, type K-1.

Description: This transformer consists of a primary and three secondary windings, the latter to provide output voltages of 1½, 2½ and 5 volts for the operation of 226, 227 and 171 valves, respectively. It supplies all the filament current for the valves in a receiver designed for complete AC operation. The transformer measures 3½ inches in width by 3½ inches in height, and is 4 inches in overall depth. It is inclosed on five sides in a metal case, and has a composition terminal panel for the front side. It is equipped with a power switch intended for mounting on the front panel of the receiver, and there is also an outlet tap in the top of the transformer into which the "B" power-pack may be plugged, in which case the latter will also be turned "on" and "off" from the receiver panel switch.

Outstanding features: Supplies all filament voltages required in the average AC receiver. Small in size. Controlled from receiver panel switch.

Maker: Bremer-Tully Mfg. Co.



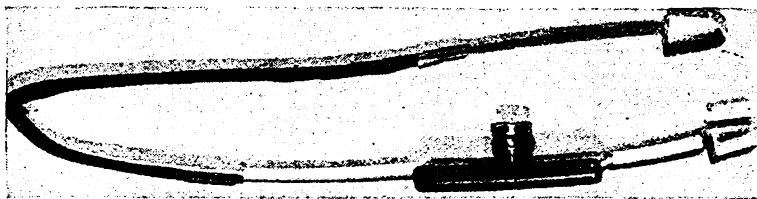
An Automatic Filament Control for Screened-Grid Valves

Name of instrument: Amperite No. 622 filament control.

Description: This is the latest addition to the amperite family and is intended for use with the new CX-322 screened-grid valves when operated from a 6-volt source, as from a storage battery. An amperite connected in series with the filament of one of these valves causes the filament to operate at substantially the rated voltage.

Outstanding features: Maintains proper working voltages for the 322 type valve. Eliminates necessity for an adjustable rheostat.

Maker: Radiall Co.



A Handy Lead-in and Arrester

Name of instrument: Combination lead-in and lightning arrester.

Description: This is a convenient unit for use, inasmuch as it includes a flat, insulated lead-in and a lightning arrester in a single unit and requires a total of only three connections. The antenna connector terminals are of the sliding clip type and the ground con-

nection to the arrester is made to a screw terminal. The overall length of the unit is 16 inches and the insulated section where it passes under a window is 6½ inches in length.

Outstanding features: Easily installed. Lightning arrester outdoors. Good contact assured by clips.

Maker: Swan-Haverstick, Inc.



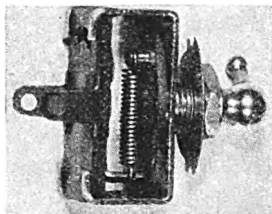
A Compact "C" Battery Eliminator

Name of instrument: "C" power supply.

Description: This unit is in the form of a small metal box, finished in crystal-line and with a bakelite top upon which the terminals and controls are mounted. Its overall size is 3 by 3 by 5½ inches. To connect it into any circuit, it requires only that the negative side of the filament circuit be connected to one of its terminals and the negative side of the "B" power-pack be connected to another. Two "C" voltages are provided by this unit and both are adjustable by means of control knobs on the top of the instrument. This arrangement has the advantage over "C" batteries that, when its two control knobs have once been adjusted, any variation in the output voltages of the "B" power-pack will cause similar variations in the "C" voltage, with the result that the "C" bias is maintained at approximately the proper value.

Outstanding features: Easily connected. Eliminates "C" batteries. Provides automatic control of "C" bias.

Maker: Arionola Sales Co.



A Switch That Eliminates Relays

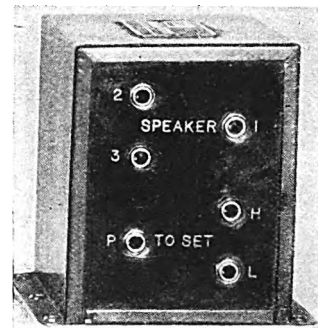
Name of instrument: Power switch.

Description: There has been a growing demand for a switch to be mounted on the receiver panel which would control the 110-volt AC supply to the receiver, particularly where the receiver employs AC valves. This new

switch is designed to control either an "A" battery or the 110-volt AC supply, and is mounted on the receiver panel by means of a single ¾-inch hole. The toggle control lever and the metal frame of the switch are both insulated from the contact elements. It measures only 1¼ inches by ¾ inch by ⅝ inch in depth.

Outstanding features: Compact size. Capable of carrying 110 volts AC. Positive in action and shock proof.

Maker: Carter Radio Co.



An Unusually Practical Speaker Coupling Unit

Name of instrument: B-T speaker coupler, type S-1.

Description: This neat unit is intended for coupling the reproducer to receivers which employ power valves in the last low-frequency stage. The overall dimensions are 3½ inches each way, which is small enough to permit mounting the unit inside of most receivers. Terminals take the form of phone tip jacks. The coupling is provided by a transformer with both primary and secondary windings tapped. The tapped primary is for the purpose of matching up the primary load impedance for the best value for working with the impedance of the valve used in the last stage of the receiver; thus the transformer serves with equal effectiveness with either a 210 or a 171 type valve in the last stage. The secondary tap provides a choice of two degrees of coupling, and meets the impedance requirements of several types of reproducers.

Outstanding features: Adjustable input and output impedances. Easily installed in a receiver.

Maker: Bremer-Tully Mfg. Co.



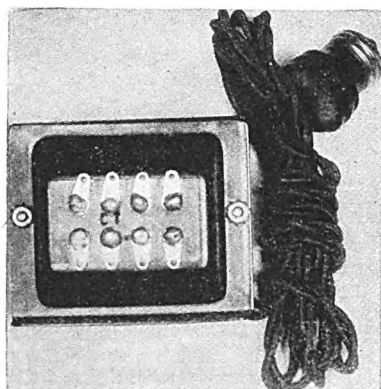
Adjustable Plate Voltages From Any Power-Pack

Name of instrument: Vitrohm Adjustat, type No. 507-77.

Description: This unit is in reality a heavy-duty, high-resistance potentiometer. It is available in several different values of resistance, from the type No. 507-79, which has a maximum resistance of 1 ohm, to the type No. 507-78, with a maximum resistance of 25,000 ohms. All are rated at 20 watts. The particular adjustat illustrated here has a maximum resistance of 10,000 ohms and is capable of carrying 40 milliamperes continuously. The slider, instead of sliding over the resistance winding, slides over copper studs which are connected at regular intervals along the winding. This arrangement eliminates wear on the resistance wire and also permits complete enclosure of the winding proper. The unit is provided for single hole mounting and is equipped with a bakelite knob.

Outstanding features: When one or more are used in series as the resistance network in the output of a power-pack, it is possible to obtain adjustable plate voltages for all valves in the receiver with which the power-pack is used. A variety of types available for any purpose where an adjustable, heavy-duty resistor is required. Accurate in rated values and thoroughly insulated.

Maker: Ward-Leonard Electric Co.



A Filament Heating Transformer for AC Valves

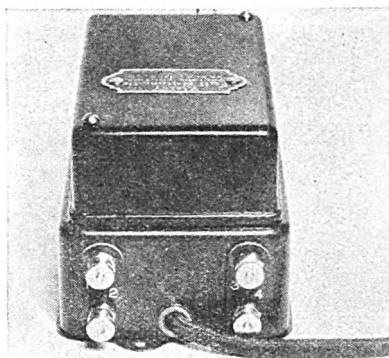
Name of instrument: Filament heating transformer, No. 464-131.

Description: The size of this transformer is $3\frac{1}{8}$ by $3\frac{1}{4}$ by $3\frac{1}{4}$ inches. It supplies output voltages of $1\frac{1}{2}$ for AC valves of the CX-326 type up to six in number; $2\frac{1}{2}$ volts for a C-327

detector valve; and 5 volts for one or two power valves of the 371 type. This transformer is therefore capable of meeting the requirements of practically any AC receiver. The $2\frac{1}{2}$ -volt and 5-volt windings are center tapped. The transformer operates from the 100-120-volt lighting lines, 50 to 133 cycles. It is also obtainable in type No. 464-132 for same voltage at 25 to 40-cycle supply.

Outstanding features: Compact. Low priced. Will supply the AC filament needs of most sets.

Maker: Jefferson Electric Mfg. Co.



A New Automatic Relay

Name of instrument: Yaxley No. 440 full automatic power control.

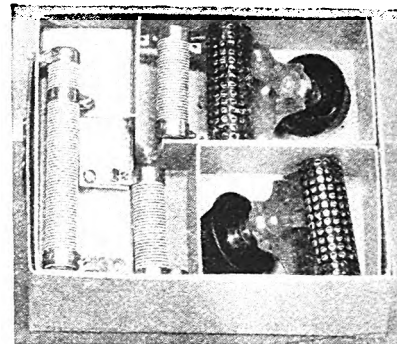
Description: This is a new type of relay which not only automatically connects or disconnects the "A" and "B" power supply, but also prevents the trickle charger from charging the battery to a point where damage will result. As soon as the battery becomes charged to a sufficiently high point, a second relay is thrown into operation and the charger is disconnected from the "A" battery.

With this relay, three automatic operations are possible. When the valves of a radio receiver are switched on, the trickle charger is automatically disconnected from the storage battery, and the "B" battery eliminator is automatically connected to the 110-volt lines. When the valves of the receiver are turned off, the "B" eliminator is automatically disconnected from the AC line and the trickle charger again automatically connected to the proper "A" battery terminals. While this function has been performed by the Yaxley type 444 relay, the new type 440 relay performs the added function of standing guard over the "A" battery charger, cutting it off when the battery has become fully rehabilitated.

The relays are mounted under a pressed steel cover and adequately protected from damage. Four terminals on the back of the relay are used to make the necessary connections between the "A" battery, trickle charger and the receiver. The front of the relay is provided with two electrical receptacles; one to supply the trickle charger with its 110-volt input supply, and the other to supply the "B" battery eliminator.

Outstanding features: Unusually good mechanical construction. Relay provided with large contacts, and long extension cord provided.

Maker: Yaxley Manufacturing Co.



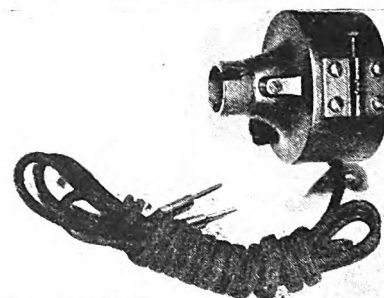
A Resistor Kit for the "H-Q" Power-Pack

Name of instrument: Truvolt "Hi-Q" resistor kit.

Description: This set of heavy-duty resistors provides all the resistances required in the construction of a power-pack for the Hi-Q "Six" receiver. It consists of three fixed resistors and two variable resistors, the latter to provide variable detector and high-frequency plate voltages and a variable "C" bias voltage for the power valve. All of the resistors employ the "Truvolt" type of resistance winding and are designed with an ample safety factor so far as current carrying capacity is concerned. The sliding contacts of the variable resistors work smoothly and provide positive contact.

Outstanding features: Resistance values correct to provide the voltage values required by the Hi-Q receiver. Ample current carrying capacity. Small in size and easily mounted.

Maker: Electrad, Inc.



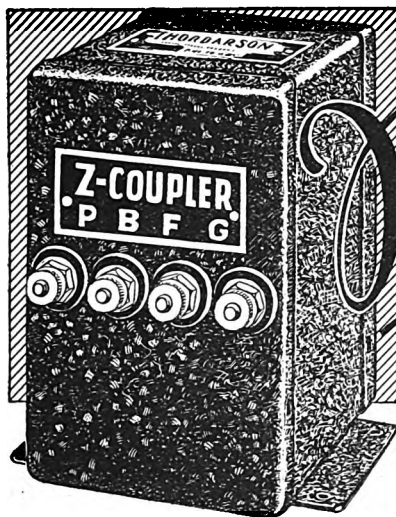
A Pick-up Unit for Old Phonographs

Name of instrument: Baldwin "Needle-phone" phonograph pick-up unit.

Description: This pick-up unit is inclosed in a neat bronzed metal case with needle holder and set screw on one side and with an adjustable collar for attachment to the tone arm of a phonograph. It does not require batteries in its operation. It is provided with an extension cord equipped with a pair of tips for connection to the input terminals of a two-stage low-frequency amplifier. When thus connected to the amplifier and with the unit mounted on the tone arm of any phonograph, it is only necessary to operate the phonograph in the usual way to obtain a high grade of reproduction.

Outstanding features: Easily adaptable to different types of phonograph tone arms. Neat appearance.

Maker: Nathaniel Baldwin, Inc.



The Thordarson Z-Coupler, a special audio impedance coupler for use with screen grid tubes; price each, \$12.

New! SCREEN-GRID Audio Amplification

Screen grid audio amplification, most revolutionary development in audio systems since the introduction of the power tube, is now an established fact.

The Thordarson Z-Coupler is a special audio coupling device designed for use with the screen grid tube UX-222.

With the remarkable amplification thus obtained a mere whisper from the detector is stepped up to a point that gives the power tube all it can handle in the way of signal voltage. In fact, one stage Z-Coupled audio has the amplification equivalent of two, or even three, stages of ordinary coupling. Signals barely audible before may now be heard at normal room volume.

In tone quality, too, the Z-Coupler is unexcelled. Despite the high amplification the tonal reproduction is as nearly perfect as any audio amplifier yet developed. Both high and low notes come through with the same volume increase. Even at 60 cycles the amplification is over 95% of maximum.

Regardless of the type of your receiver you can vastly improve its performance by including this new system of amplification. The Z-Coupler replaces the second audio transformer, with very few changes in the wiring. The screen grid tube is used in the first audio stage. No shielding is required.

THORDARSON Z-COUPLER

THORDARSON ELECTRIC MANUFACTURING CO.

Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Huron and Kingsbury Streets - Chicago, Ill. U.S.A.

Write To-Day for Complete Information

THORDARSON ELECTRIC MFG. CO.
Huron and Kingsbury Sts., Chicago, Ill.
Gentlemen:

Without obligation on my part, please send me complete information on screen grid audio amplifiers using your new Z-Coupler. (3578-C)

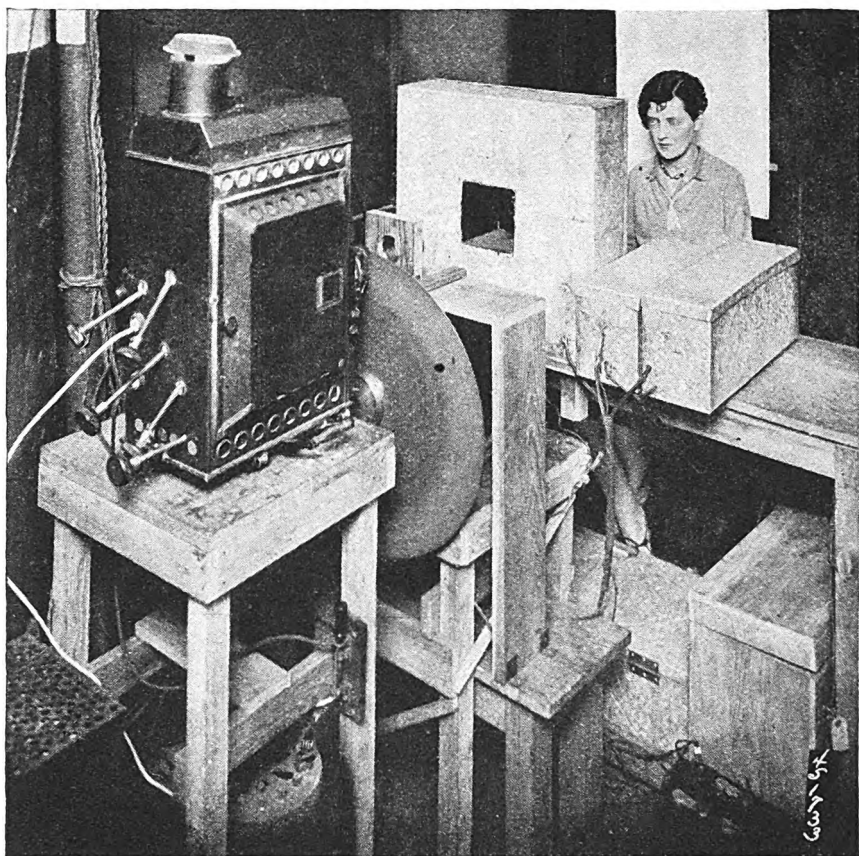
Name

Street and No.

Town State

In the World's Laboratories

(Continued from page 397)



THE SCANNING DISC METHOD

The more accepted method of television transmission is by the use of a scanning disc such as is shown above. This disc, interposed between the powerful light in the foreground and the image to be transmitted, guides the light beam, by means of small spirally placed holes, so as to cover every part of the image.

rays. The glowing patches correspond to the light and dark parts of the object.

The cathode ray tube employed by Dr. Dieckmann is similar in its construction to the cathode ray oscillograph tube which was introduced by the Bell Telephone Laboratories a few years ago, and which is illustrated in the accompanying picture.

New Radio Circuit Does Not Clip Sidebands

IN A paper delivered at the opening session of the recent convention of the Institute of Radio Engineers, Dr. Frederick K. Vreeland outlined the basic principle of his development which permits reception of the full sidebands of a broadcast signal without loss of se-

lectivity. This is accomplished by means of a system of balanced reactances, which is called a "band selector" inserted in the high-frequency circuit.

The characteristics of this new discovery, its inventor claims, give full leeway for the reception of all the sidebands necessary for faithful tone reproduction.

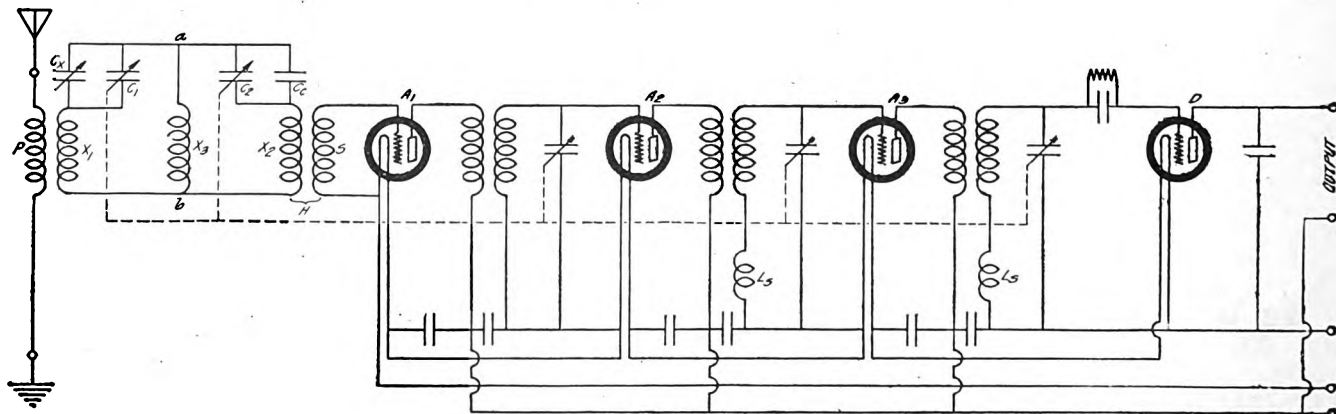
The geometric method of tuning developed by Alexanderson is not used at all in this new circuit. According to Dr. Vreeland, geometric tuning is responsible for much of the distortion of tone in radio reception, because it trims off the sidebands of the signal wave, and the sidebands are what give the tone quality to reception.

The "band selector" is a simple circuit which has the remarkable property of balanced reactances at all the frequencies within a band of 20 kilocycles. An ordinary tuned circuit has its reactances balanced at only one frequency. The balanced reactances are variable and are adjusted by means of an ordinary dial.

Sharp tuning is due, Dr. Vreeland claims, to the unique characteristics of his "band selector." A broadcast signal wave includes sidebands to a width of 20 kilocycles. In an ordinary circuit, the response curve rises to a sharp point, cutting off much of the sidebands. In his circuit Dr. Vreeland shows the response curve takes on the appearance of a rectangle, rising sharply, flattening out at the top to almost the entire 20 kilocycle width, and then descending sharply, thus taking in practically all of the sidebands, yet cutting off the interfering wave sharply at the base.

Distortionless reception and faithful reproduction of tone means that all the frequencies in the transmitted band of the modulated wave shall be received in their true relative intensities. Selectivity requires that a certain group of radio frequencies, comprising a modu-

(Continued on page 408)



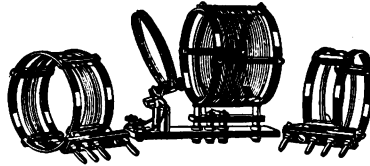
THE "BAND SELECTOR" CIRCUIT

This receiving circuit, Dr. Vreeland claims, is able to receive with equal amplitude all frequencies within a 20-kilocycle band, and exclude all frequencies outside this band. See the oscillograph records on page 408.

Build the Short-Wave Converter Described in This Issue!

Here are the AERO COILS you will need

This kit is the basis of the short wave converter described in this issue.



Experts and amateurs everywhere have found that this Aero Kit improves any circuit.

AERO LOW WAVE TUNER KIT Code No. L. W. T. 125, Price \$12.50

EVERYONE interested in short wave reception should read about the short wave converter described elsewhere in this issue of POPULAR RADIO. This superlative set is designed on sound engineering principles and produces extremely satisfactory results.

Always the prime favorite of experts and amateurs insistent upon extraordinary short wave performance, the Aero Low Wave Tuner Kit is again specified in this set. Greater volume, finer selectivity, better tone quality and flexibility to a

degree never before thought possible is assured by use of these coils.

The Aero Low Wave Tuner Kit illustrated above is completely interchangeable. The kit itself includes three coils and base mounting covering U. S. bands 20, 30 and 80 meters. You can increase the range to 725 meters or decrease the range to 13 meters by securing Aero Interchangeable Coils Number 0, 4 and 5. All coils fit the same base and use the same condensers.

NEW AERO CHOKE COILS



The new Aero Choke 60 has a uniform choking action over a wide range of wave lengths. It eliminates so-called "holes" in the tuning range and is exceptionally efficient in every respect.

Price..... \$1.50



The Aero Choke 248 is an unusually efficient transmitter choke. It presents a high impedance over the usual amateur wave lengths and handles transmitters up to 100 watts.

Price..... \$1.50

Plan for DX Records NOW

*Order any of these Aero Coils direct from us if your dealer doesn't happen to have them.
Be sure to specify code numbers when ordering.*

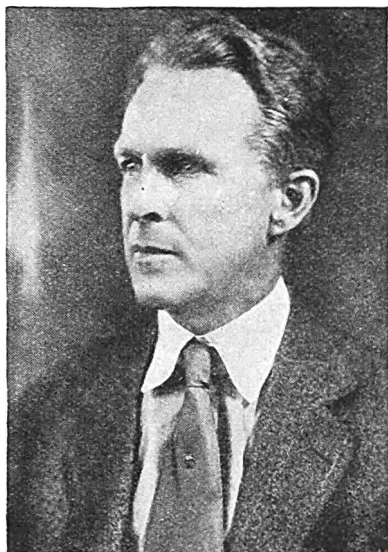
AERO PRODUCTS, Inc., 1772 WILSON AVE., CHICAGO

Dept. 104

It will pay you to investigate the new Aero Amateur Transmitter Coils and improved Aero Universal Coil, designed for broadcast band usage. These coils are supplied in complete kits for the improved Aero-Dyne Six, the Aero Seven, the Aero Four and other popular circuits. Write for interesting descriptive literature on these and other new Aero products.

In the World's Laboratories

(Continued from page 406)



DR. FREDERICK K. VREELAND, THE AUTHOR OF THE NEW CIRCUIT.

lated signal wave, must be separated from all other radio waves.

If we are to receive a full frequency band, or spectrum, of 20 kilocycles width, including modulation frequencies up to 10,000 cycles, obviously the bands of two modulated waves of 20 kilocycles apart will meet with no space between them.

It is claimed that the band selector developed by Dr. Vreeland meets these three stated conditions, i.e., fidelity, selectivity and simplicity. It comprises, in summing up, a system of reactances so related to each other that they are mutually balanced, not merely at a single frequency, as in the case of the ordinary tuned circuit, but also at any frequency within a given band. At any frequency outside of this band the reactances are not balanced and the unbalanced reactance is high. As a result of this property, the band selector unit responds with substantial equality to all frequencies within its characteristic band and is non-responsive to frequencies outside this band. When the system is suitably designed, the cut-off at the limits of the band is very sharp. The electrical and mechanical construction is exceedingly simple, and frequency adjustment is obtained by means of only two variable elements operated by a single control.

Echo Rooms for Broadcast Stations

IN AN attempt to add still greater realism to broadcast transmission, an English experimenter and inventor, H. J. Round, has devised an ingenious method of producing echoes, the echo being transmitted simultaneously with the original sound. It is claimed that this method greatly enhances the tonal qualities of the music transmitted, and

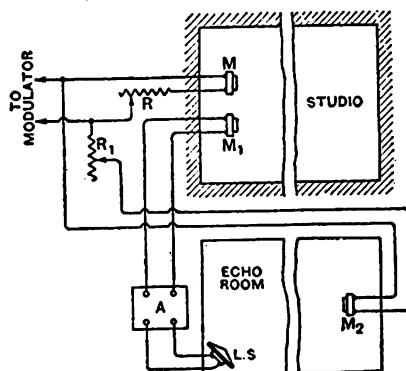
that it produces a more natural response at the received points.

Our ears are accustomed to hearing echoes. When a symphony plays in a great hall, echoes always accompany the music. As a matter of fact, echo-less music, except in specially prepared broadcast studios, is almost impossible to produce.

To create a radio echo, Mr. Round proposes to use two studios, one of which he calls the echo room. The echo room is really a dummy studio in which there is placed a reproducer connected to a telephone receiver which is placed in the main studio and which is connected to the loudspeaker through a low-frequency amplifier. Thus the music played in the main studio is reproduced in the echo room, where it is again picked up by a microphone and carried to the input of the modulating valves of the radio broadcast transmitter. The dummy or echo studio is free from the usual hangings or drapery used in the main studio, and the microphone picks up all the echoes or reverberations that are produced and which Mr. Round claims are so vital in adding good tonal color and naturalness to the received signal. Rheostats are provided to adjust the relative strengths of the currents flowing in the various microphone circuits.

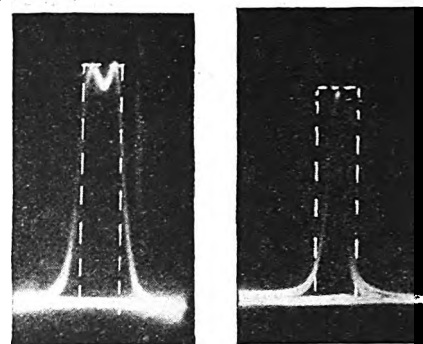
A New German Super-Power Reproducer

SOME authorities on acoustics hold that the principles of the cone reproducer are under a disadvantage in that the driving force is applied virtually at one point on the cone, and that standing waves may be set up in the material of the diaphragm, between the apex and the suspended edge. In an effort to overcome this supposed deficiency, the engineers of Siemens & Halske have designed a super-power speaker operat-



THE WIRING OF THE ECHO ROOM

The broadcast from the studio is picked up by the microphone M1 and delivered to the reproducer in the echo room. There it is picked up again by the echo microphone, M2, and fed back to be modulated with the original broadcast picked up by the studio microphone, M.



THE OSCILLOGRAPH RECORDS

At the left is the Vreeland wave, showing remarkable broadness at the top with very steep sides, and at the right is an ordinary wave. The dotted lines indicate a breadth of 20 kilocycles.

ing on the electrodynamic principle. The main object of the design of the new unit is to distribute the driving force over the entire surface of the vibrating medium or diaphragm. The principle used is really that which is now being employed in what we call our moving coil reproducers, similar to the Magnavox and the Radio Corporation's No. 104 power speakers. In these speakers, movement is obtained by permitting the output of the low-frequency system of the radio receiver to flow through a coil suspended in a powerful magnetic field maintained by a separate source of energy. Precisely the same idea is employed in the electrical measuring instruments of the D'Arsonval type.

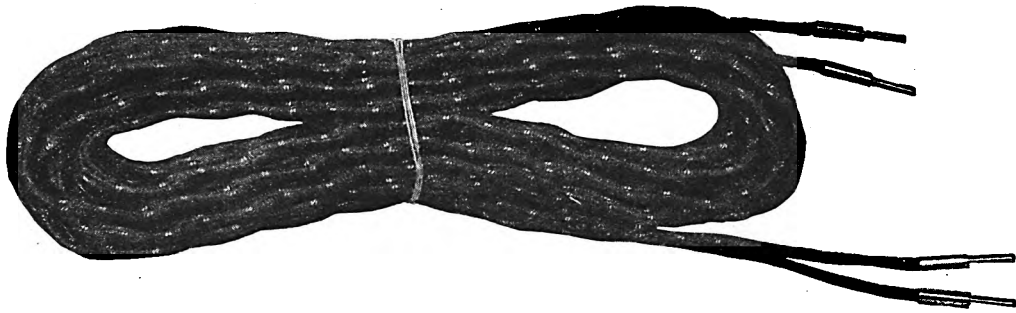
The moving coil is wound back and forth between the pole faces of a series of powerful magnets. The coil is especially massive, being made up of heavy copper strip, which naturally has a very low value of impedance. A special impedance balancer or matching unit is therefore connected between the amplifier and the moving coil.

The moving coil is attached directly to the diaphragm. Fluctuating currents from the output transformer of the receiver amplifier react with the field between the poles and the magnet, and since the current is the same in each part of the strip the force exerted is the same at each point, assuming that the separate magnetic field is maintained at a uniform value.

The diaphragm of this huge reproducer has an effective vibrating area of 400 square centimeters, and the electromagnets absorb approximately 600 watts in maintaining the permanent magnetic field surrounding the strip winding. Large baffle boards are used to insure proper radiation at the low frequencies.

This reproducer was first used in public at the opening of the German Museum in Munich and it has since attracted much comment from the German public during demonstrations.

(Continued on page 410)



Stop Leaks with these Safe High Power Cords

THIS Gavitt high-power speaker cord has been developed especially for high-power radio receivers having output voltages as high as 1500. Standard tinsel speaker cords are inadequate for this use, owing to their susceptibility to moisture and mechanical injury. The Gavitt high-power cord is heavily insulated with rubber, and twisted so as to minimize AC hum in the event the cord is laid parallel to fixture cords. This cord is guaranteed leak-proof and safe in every way, and its use guarantees against short-circuits in power amplifiers. Twisted cords supplied in 5, 25, 30, 50 and 100 foot lengths.

GAVITT untwisted speaker cords are strong, durable, and moisture-proof. Their braided coverings are woven tightly and are able to withstand more than normal abuse. Although these cords are not twisted, they are very carefully insulated and may be used safely for every radio purpose, being able to withstand voltages up to 1500. Each speaker cord comes supplied with standard tips and may be had in 5, 25, 30, 50 and 100 foot lengths.

THE Gavitt Manufacturing Company specializes in the production of high power cords, tinsel speaker cords, AC service cables, hookup wire, battery cables, and chassis and panel cables. These products are made especially for the use of manufacturers, professional and amateur set builders. No order is too large for the facilities of the Gavitt organization, nor is any order too small to receive prompt and courteous attention. The Gavitt Manufacturing Company supplies wire products to the largest manufacturers of radio equipment in the world.

High-Power Speaker Cord Price List

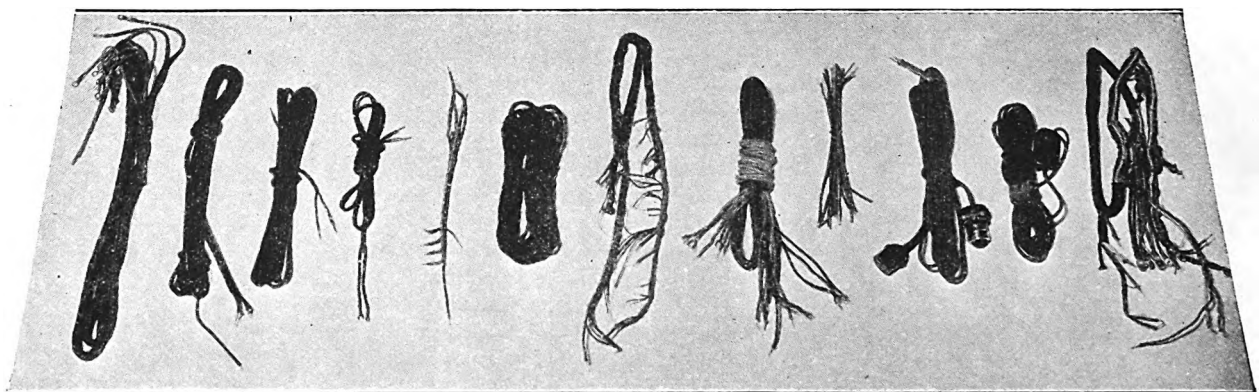
REGULAR CORD			TWISTED CORD		
5 ft.	with connector	\$.25	5 ft.	with connector	\$.30
25 ft.	" "	1.20	25 ft.	" "	1.40
30 ft.	" "	1.35	30 ft.	" "	1.55
50 ft.	" "	2.00	50 ft.	" "	2.20
100 ft.	" "	4.00	100 ft.	" "	4.20

(All Rubber Insulated)

(All Rubber Insulated)

Quotations on special cable problems gladly given. Complete price list for all Gavitt products will be mailed on request.

Send for literature and prices on our standard products
"RELIABLE" WIRE PRODUCTS



GAVITT MANUFACTURING CO.
BROOKFIELD, MASSACHUSETTS

In the World's Laboratories

(Continued from page 408)



Underwood and Underwood

ATOMIC NOISES MAKE THEMSELVES AUDIBLE

A gathering of scientists at the Engineering Auditorium in New York witnessed this unusual demonstration of atomic upheaval in a magnetized bar of iron. The sounds of the atoms turning about in response to magnetic impulses was amplified ten billion times and made audible to the entire audience through a loudspeaker.

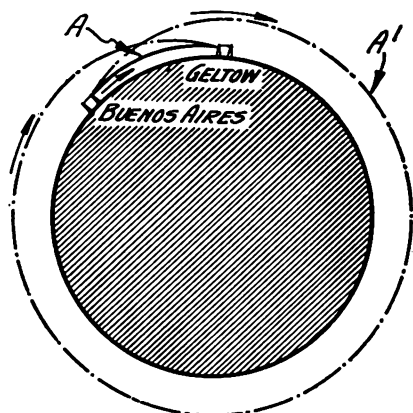
Rush of Atoms Heard in a Reproducer

Noises made by billions of atoms turning over in their beds inside a bar of iron were heard by New York scientists when Dr. H. Clyde Snook, Consulting Engineer of New York City, addressed the New York Electrical Society on "Scientific Conquests of 1927." When iron is magnetized, Dr. Snook explained, it is believed that vast numbers of atoms inside the iron turn around so that all face the same way, as soldiers turn on word of command. In Dr. Snook's demonstration the tiny disturbances created by these acrobatics were magnified electrically to more than ten billion times their original strength and were broadcast to the audience through a powerful reproducer recently

developed by the Westinghouse Electric & Manufacturing Company. They sounded a good deal like a carload of dumb-bells turning over as they rolled down a tin roof.

Another noise recovered from the realm of atoms and electrons by the enormous magnifying power of the modern electric apparatus was demonstrated to the society by its discoverer, Dr. J. B. Johnson, of the Bell Telephone Laboratories, New York City. This is the noise made by the tiny particles of electricity jostling against each other when a current flows through a wire. It sounds something like water rushing through a gigantic pipe. Still a third atomic sound was explained by Dr. Snook as the noise made by cooking electricity out of the hot filament of a radio vacuum valve. It sounds not unlike grease frying out of an enormous piece of bacon. By way of contrast to these unusual sounds, phonograph music was reproduced electrically by the new Westinghouse instruments with volume greater than that of a large orchestra.

The means employed for amplifying the minute electrical effects produced by jostling electrons and atoms is that of vacuum valve amplification. Powerful vacuum valve amplifiers of special construction are used to make audible the apparently terrible noises that are beyond the range of the human ear.



AROUND THE WORLD IN 0.137 SECOND

Part of the signal impulse from the station at Buenos Aires was received at Geltow after traversing the distance A. Another part of the signal impulse, A', passed completely around the world and was received .137 second later at the same station.

ference. That this reasoning is not necessarily true has been proven on various occasions, and recent experiments at Geltow, Germany, prove beyond all possible doubt the fallacy of this theory. Observers at this point, which is near Berlin, showed that at certain times short waves may travel entirely around the earth's circumference and be received an infinitesimal fraction of a second later at the point where they were first received.

The observations which have finally established this fact were conducted with the assistance of an automatic recording apparatus employing high amplification used in conjunction with an oscillograph, the incoming signals being recorded on a photographic tape strip and carefully analyzed to establish the time element.

The graph shown on this page is a drawing made from the photographic record produced on the oscillograph. A dot was received at Geltow on a wavelength of 15.66 meters from a certain station in Buenos Aires. This dot, indicated in the diagram at A, was followed exactly 0.137 second later by a second dot of diminished intensity, A'. These dots were both of exactly the same length, and since they were received with a time separation, 0.137 second, which would be the time required for a signal to circumnavigate the earth at a speed of 186,000 miles a second, there is no doubt but that the wave causing mark A' had traversed the earth before it was recorded.

Considering the great distance traversed by echo impulses, it is amazing to compare its energy with that of the original signal. Yet the faithful oscillograph shows that the amplitude—which is an indication of energy—of the second impulse is astonishingly large when compared with that of the original. Would these experiments seem to prove that there is a definite limit to the degree of sensitivity which we can employ in our receivers? It is obvious that any receiver sensitive enough to receive the original and echo impulses could not afford perfect reproduction, since the echo impulses would obviously be out of phase with the original to the degree of 0.137 second.



A RECORD OF THE FASTEST TRIP AROUND THE WORLD

The copy of an oscillograph record shows the original signal, A, received at Geltow, and the echo signal, A', received .137 seconds later. The time interval indicates that the radio waves, travelling at 186,000 miles a second, passed completely around the earth.

Short-Wave Echoes

IN THE early days of radio it was assumed by the investigators of the day that the maximum distance which a radio wave could travel amounted approximately to one-half the earth's circum-

The Individual Tube

THE ZETKA PROCESS SPECIAL DUTY TUBES

This new line of tubes—to deliver the results of which they are capable—require proper operation.

We are trying to restrict their distribution to Dealers who cater to "Fans," Amateurs, Professional Set Builders and Service organizations—the "RADIO-WISE" buyers who handle laboratory products most intelligently.

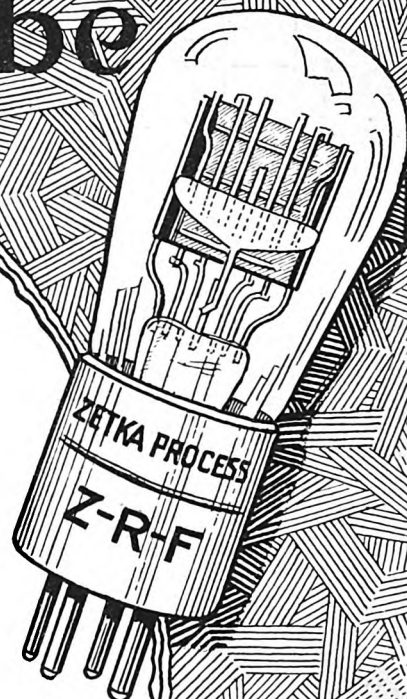
If your dealer cannot yet supply you, we will appreciate your sending us his name and address. In the meantime, we will fill your order direct on receipt of your check or money-order—or C. O. D., if you prefer.

—ZETKA PROCESS SPECIAL DUTY TUBES are guaranteed to give complete satisfaction in your receiver provided they are operated according to the instructions accompanying each tube.

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ZETKA
CLEAR GLASS TUBES



Z-R-F—Radio Frequency Amplifier, 5 volts, $\frac{1}{4}$ amp. High amplification constant. Low plate impedance, and low internal capacity. Uses 90 volts on plate....Price \$4.50

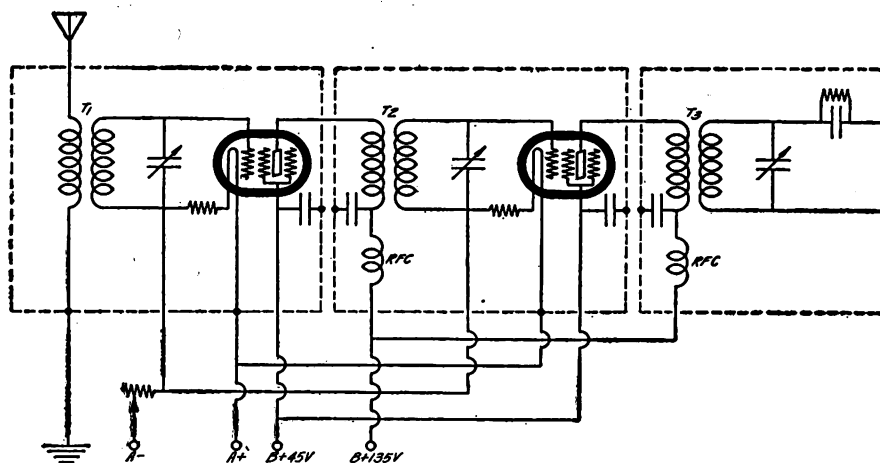
Z-D—Super-sensitive Detector, 5 volts $\frac{1}{4}$ amp. High amplification constant. Silent (no hiss). Uses 45 volts on plate.....Price \$4.00

Z-A-F—Audio Frequency Amplifier, 5 volts, $\frac{1}{4}$ amp. Higher Mu, low impedance. Plate voltage 90 to 135 Price \$4.50

Z-A-O—Audio Output, or Power Amplifier, 5 volts, $\frac{1}{2}$ amp. For handling large output volume without distortion. Plate voltage 180, with 22 $\frac{1}{2}$ volts "C".....Price \$4.50

In the Professional Set Builder's Shop

(Continued from page 400)



A TYPICAL SCREEN GRID HIGH-FREQUENCY CIRCUIT

FIGURE 4: This high-frequency amplifier circuit has been worked out with the characteristics of the screen grid valve in mind, and is devised to take full advantage of their virtues.

What Screen Grid Valves Mean to the Set Builder

INTENSE interest has been aroused among professional set constructors as to just what effect or benefit the new screen grid valves will hold for them. There seems to be belief in some quarters that this new valve, which has been designated the CX-322, can be substituted for the old-type valves in the high-frequency portion of existing receivers.

Actually the screen grid valve cannot be used except in a specially designed amplifier. The first reason for this is that the control grid terminal is no longer one of the contact prongs in the base of the valve, but instead is brought out at the top of the valve. This means that the grid connections from the coil and condenser are to be made to the top of the valve and the special connections to the new screening grid are to be made to the terminal of the socket that is used for the control grid connections in the usual hookup for standard valves.

The filament requirements of the new valve are much different from those of the standard CX-301-a type valve, in that the new valve filaments operate on 3.3 volts instead of 5 volts, and the filament current required by the screen grid valves is only half that required by 301-a's.

Finally, and perhaps most important of all, the screen grid valves cannot be used to any advantage with the usual type of tuned-high-frequency transformer. They should be used with either tuned-impedance coupling or with high-frequency transformers that have a turn ratio between primaries and secondaries of about 4 to 5. The usual ratio of about 1 to 6 is practically useless.

If more evidence of the necessity for

a special circuit is needed, it is found in the fact that the screen grid valve requires a small negative "C" bias on the control grid and a totally new circuit for the screen grid connections.

In circuits especially designed for the new valves, they offer some really remarkable possibilities. A single stage of well-designed high-frequency amplification, employing the CX-322 screen grid valve, is capable of providing up to five times the amplification obtained with a correspondingly well-designed stage which employs a CX-301-a type valve.

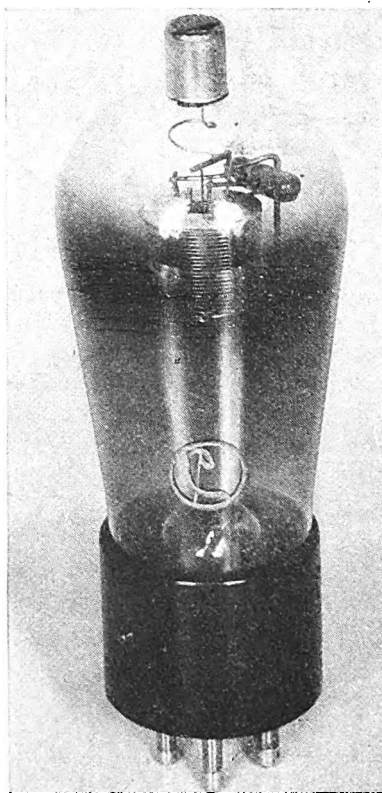


FIGURE 5: THE CX-322 SCREEN GRID VALVE

Their second outstanding feature is the fact that these new valves require no neutralizing because the internal shielding afforded by the screen grid eliminates internal feedback. They are, however, susceptible to external feedback through undesirable interstage coupling, and therefore require careful shielding. As a matter of fact, shielding is more imperative in a two-stage high-frequency amplifier which employs these valves than in a similar amplifier which uses CX-301-a type valves, because of the far higher amplification obtained with the new valves.

Filament requirements of the CX-322 type valves are low enough to permit the use of dry-cell batteries in a receiver where the balance of the valves are of the CX-299 type. The filament current consumption is only twice that of a valve of the CX-299 type and the filament voltage is the same as for the CX-299.

Preliminary tests seem to indicate that as a low-frequency amplifier valve in a resistance-coupled amplifier the CX-322 type valve provides a higher degree of amplification than the standard high-mu type valves. Amplification of approximately 35 per stage is obtainable when thus used, and the frequency curve is unusually flat all the way down to below 60 cycles.

For those who wish to experiment with the new valve, a suitable circuit for a two-stage high-frequency amplifier is shown in Figure 4. The high-frequency transformers, T2 and T3, employed may be some of the new transformers now being placed on the market for use with this valve, or may be standard high-frequency transformers with a new primary wound directly over the secondary and with about four-fifths as many turns as are already on the secondary. The rheostat which controls both valves should have a resistance of 20 ohms and the fixed resistors in the negative side of each filament should have a resistance of 10 ohms. The voltage drop across these fixed resistors will provide the necessary negative bias for the grid, if connections are made as shown in the diagram. The four by-pass condensers may have a capacity as low as .006 mfd. each, although higher capacities up to .5 mfd. are to be preferred. The high-frequency chokes in the plate leads are optional.

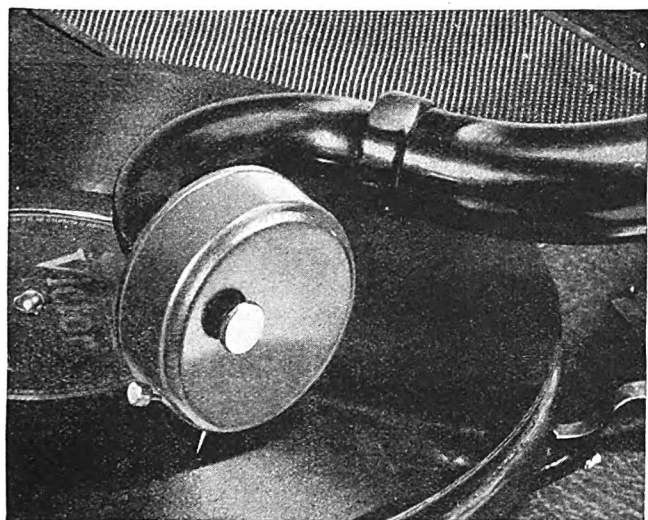
If only a single high-frequency stage is employed, the complete shielding shown in the diagram may not be necessary.

The high-frequency coupler used in the antenna circuit may be any standard high-frequency transformer for antenna tuning.

—RALPH YOUNG

(Continued on page 414)

A MUSICAL MIRACLE! *Gordon Pick-up*



Note to Manufacturers and Dealers. Our turntable department supplies turntables for all types of electric phonograph motors.

STUDNER BROS. INC.

National Sales Representatives

67 W. 44TH STREET, NEW YORK CITY

*Gives tone-results
of a \$600 phonograph
for only \$12.50 (list price)*

Even those who think that radio holds no more wonders to thrill them will be astounded by the Gordon Pick-up.

Not much, if any, larger than the old phonograph sound-box which it replaces on the phonograph tone-arm, and attached in a few seconds even by a novice, it truly works a musical miracle.

For it is the connecting link between the old-type phonograph and the radio. Its installation, in connection with the audio-frequency amplifier of any radio, gives instant radio amplification results through the loud-speaker horn, as in new-type high priced talking machines.

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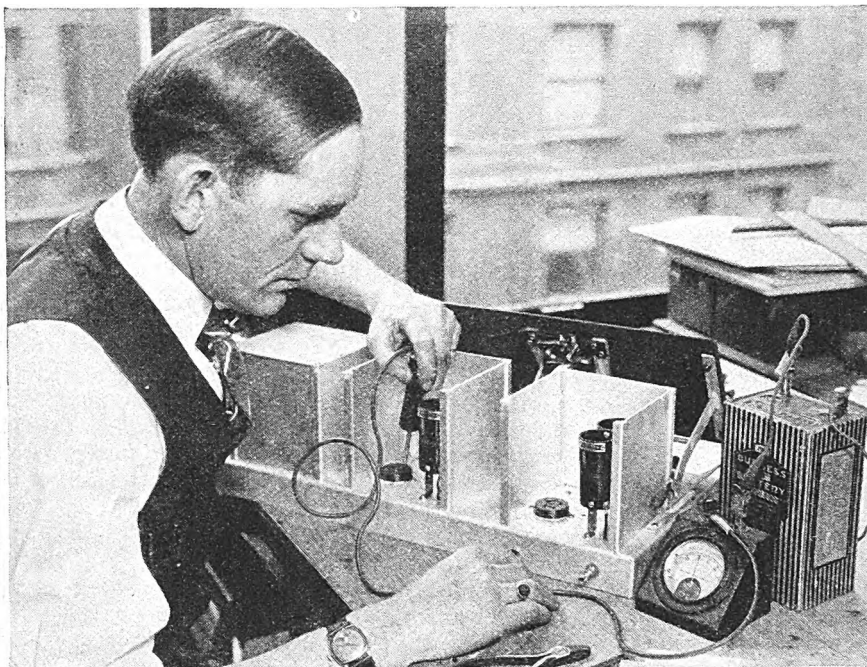
POPULAR RADIO, Inc.

119 West 57th Street

New York, N. Y.

In the Professional Set Builder's Shop

(Continued from page 412)



THE HOOK-UP FOR CONTINUITY TESTS

FIGURE 6: A 45-volt "B" battery and a high-resistance voltmeter are connected in series; and the various circuits of the receiver tested for continuity by applying the pointed tester to the proper terminals and lugs of the receiver.

How to Test a Receiver for Circuit Continuity

It is doubtful if there are any two radio service men who test a receiver exactly alike. Each one has his own particular system for going over the vital parts of a receiver and bringing to light the defects. The author's method is the result of many years' experience in servicing sets, is offered as a thoroughly practical, simple and efficient way of locating circuit defects in new or old sets.

The practise of first "hooking up" a set with batteries is not a good one. Circuits should first be tested for continuity. In the case of a newly completed receiver, these tests are especially valuable as a check against the possibility of forgotten wiring, rosin-joints, short-circuits, etc.

The LC-28 receiver, shown schematically in Figure 7, is taken as an example to illustrate the author's method. The testing equipment used

consists of a 45-volt battery (or the detector tap of a "B" power-pack), a high-resistance voltmeter of 100 volts, a battery clip lead and a pointed tester such as is manufactured by the Universal Tester Equipment Co. These units should be hooked in series as shown in Figure 6. With this hook-up the tests for circuit continuity in the LC-28 are as follows:

TEST 1: Apply the clip to the "A" positive (+) binding post, and touch the "A" positive (+) terminal of the detector socket with the pointed tester. Open and close switch A, which is part of the rheostat, several times and watch the voltmeter of the testing hook-up. The voltmeter should show a deflection commensurate with the battery voltage.

TEST 2: With the switch closed and the clip still on the "A" positive (+) binding-post, put the tester on the "A"

positive (+) terminal of the first, second and third sockets, respectively. Full reading on voltmeter should result.

TEST 3: Next place the clip on the "A" negative (—) binding-post and check as before, using the "A" negative (—) posts of the sockets.

TEST 4: Leave the clip on the "A" negative (—) binding-post and place the tester in contact with the plate terminal of each successive socket. This is to see if a short-circuit exists between the plate and filament. No voltage reading should be obtainable on the voltmeter in Test 4.

TEST 5: With the clip on the "A" negative (—) post put the tester on the grids of the sockets. This voltage should read a little less than the battery voltage, due to grid suppressor resistance and will read from 2 volts to 5 volts, dependent upon the ohmage resistance of the suppressor. The detector socket in this test will show nothing on voltmeter due to the insertion of the grid condenser. However, temporarily short circuiting the condenser with a small piece of wire will yield a voltage reading. Do not forget to remove this wire upon completion of test. In some sets, where the grid-leak is in parallel with the grid condenser, there will perhaps be an extremely low reading, but a good meter is necessary.

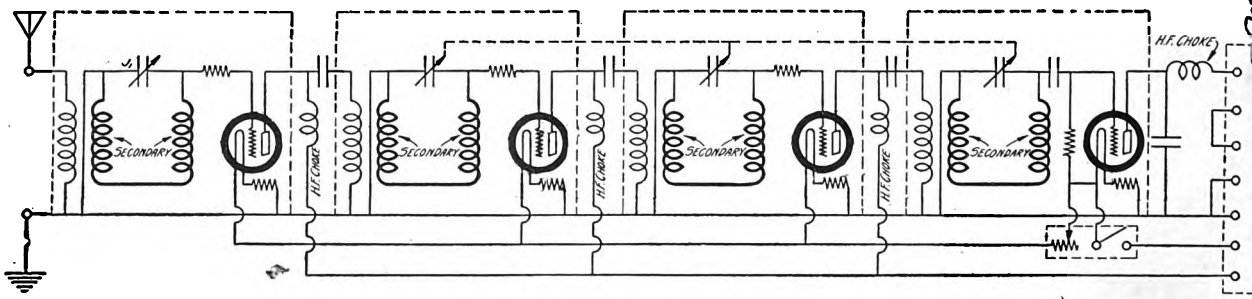
TEST 6: Test between the aerial and ground for full voltage reading, except in such instances as where a condenser is in series with the antenna.

—ROBERT W. TAIT

A Homemade Ground Clamp

A VERY good clamp for connecting the radio ground wire to a water pipe can be made from a discarded "five-minute" vulcanizer. The arms on the threaded portion are sawed off and the end of the shaft filed to a point. The base can be trimmed to a convenient shape and the ground wire fastened to it. The clamp is placed on the water pipe and the point is screwed down so as to bite into the pipe.

—L. C. FERGUSON



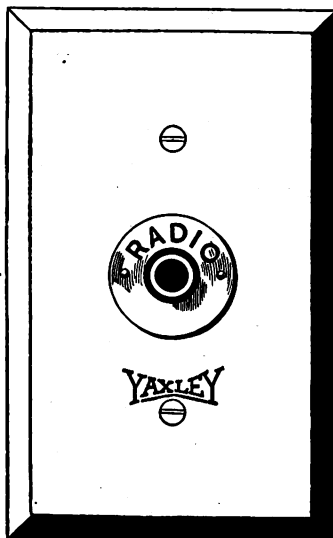
THE CIRCUIT TESTED

FIGURE 7: The circuit of the LC-28 receiver is shown above for the purpose of illustrating the tests described in the article on this page.

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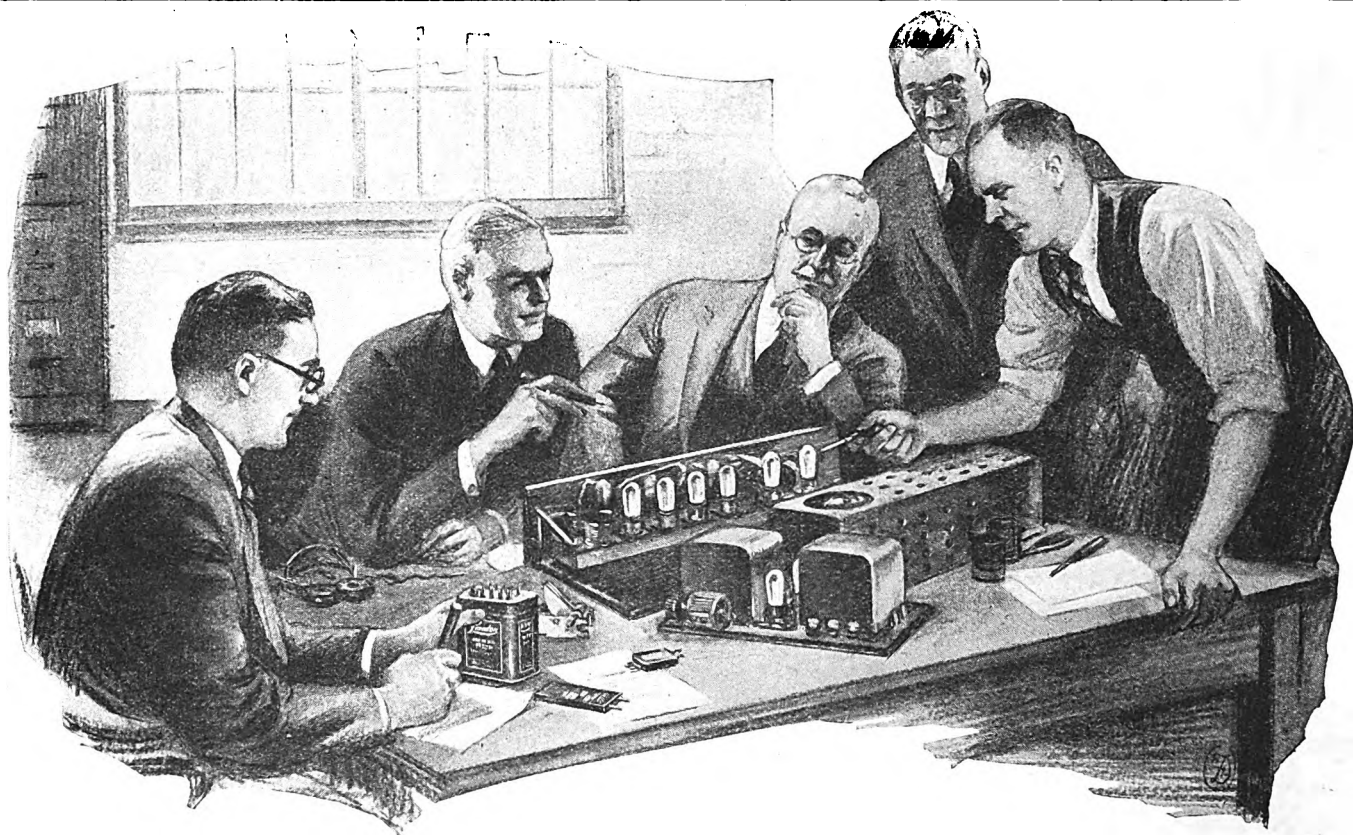
POPULAR RADIO INDEX

of Quality Sets, Kits, Parts and Accessories

A Complete Classified Index of Every Item Required in the Successful Installation and Operation of the Best Radio Apparatus

THESE ARE THE PRODUCTS of the leading manufacturers, combining fine design with high standards of quality in material and workmanship, backed by the unqualified guarantee of satisfaction by reliable organizations of the best character and highest standing. In this connection, it should be realized that no radio receiving set is better than its poorest part or accessory, that a silk purse can't be made out of a sow's ear, and that no buyer can intelligently expect to get more than he pays for. Some of the sets, parts and accessories listed are better than others. In some cases they are larger and more powerful, in others they embody more costly design, more expensive material, finer finish, more skilled workmanship, and for those reasons naturally cost more. But each is the best of its type and in its respective price field. Each represents the maximum of value and actual worth, for which you have the skilled and experienced guarantee of POPULAR RADIO Laboratory, without reservation. You may use these products with confidence, satisfaction and complete success. If you wish more detailed information regarding these products than you find in the pages of POPULAR RADIO, it will be cheerfully and promptly furnished upon request to POPULAR RADIO SERVICE BUREAU, 119 West 57th Street, New York City. Enclose 4 cents in stamps to cover mailing.

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(Continued on page 418)



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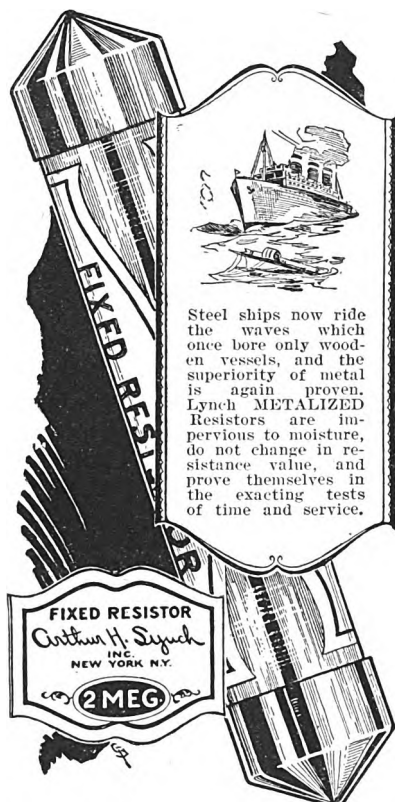
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Synchronizing Television With Light Beams

(Continued from page 382)

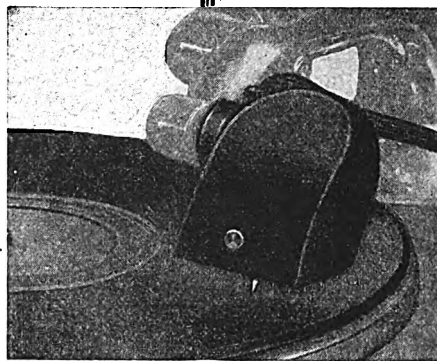
shunt-wound field coils for normal speed control.

In starting up the apparatus it is essential that the motor speed be regulated by the operator until his picture is steady, which condition implies exact timing with the incoming picture signals. Considering that the picture is steady, the successive flashes, C, reflected by the small mirror shown in the middle of the rapidly vibrating flash beam, B, in Figure 3, will register upon the chopper, K (shown also at C, in Figure 1), so that about one-half of each flash is stopped by the chopper bar and the other half falls upon the lens next to the chopper and is focused to fall upon the photo-electric cell, F. Now, suppose that the motor speeds up a little bit, causing the flashes C, Figure 1 and 3, to overlap the bars *more* than halfway, let us see what takes place: (1) The quantity of flash light which passes through the slits is lessened; (2) Dimmed lights falls upon the cell; (3) The current in the cell is decreased; (4) The current in the reversed-field coil is decreased; (5) The tendency to *reversing* the field is lessened; (6) The field itself resumes its normal full strength by virtue of its fixed shunt-winding excitation; (7) The motor slows down a little bit due to the stronger field; (8) The signal flashes are backwardly deflected by the scanning element due to the lagging action so that more light falls in the slits, passes through the lens and falls upon the cell; (9) The current in the cell and in the reversing field coil is increased, thereby weakening or de-polarizing the field; and (10) The motor again starts to speed up. This swinging, automatic, speed control cycle repeats again and again, as long as there is enough average light during each synchronizing cycle to stir up sufficient speed-up current. By providing an amplifier which has an output of about 1 watt, enough reserve energy is available for control.

Each synchronizing cycle embraces, say, an interval of 1-200th second, and consists of 200 valved flashes passing from dim illumination on the cell, to medium illumination, to bright illumination; and repeating the cycle. The frequency of the synchronizing cycle is determined by considering that 99 bar traversals occur in the time interval during which, for exact synchronism, 100 traversals should occur. Figure 2 shows such a synchronizing cycle consisting of 200 successive picture flashes progressively intercepted by virtue of underspeed and overspeed; the line G indicates the comparative value of the reverse energy required to maintain synchronization or "critical speed."

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ELECTRICALLY!



Music with
cathedral depth
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by attaching the

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The Phonovox is made in both the battery and A. C. models for sets using the UY227 or CY327 A. C. detector tubes—and either model may be attached in a few seconds' time without tools or making any changes in wiring.

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GOOD NEWS!

FOR PROFESSIONAL SET BUILDERS

DURING 1928, it is estimated that over ten million dollars will be spent in the purchase of receivers made by professional set-builders throughout the United States. Orders for custom made receivers are now being booked at an unprecedented rate and everywhere set builders are becoming more alert to the potential money-making possibilities of their craft. To help these men, POPULAR RADIO has prepared some special data which will, for a limited time, be distributed free of charge to those who write for it. Those who desire this information need only answer the following questions:

1. How many sets do you construct each year?
2. What receivers are you specializing in?
3. What do you spend for radio parts each year?
4. How long have you been in business?
5. Do you operate in full or spare time?

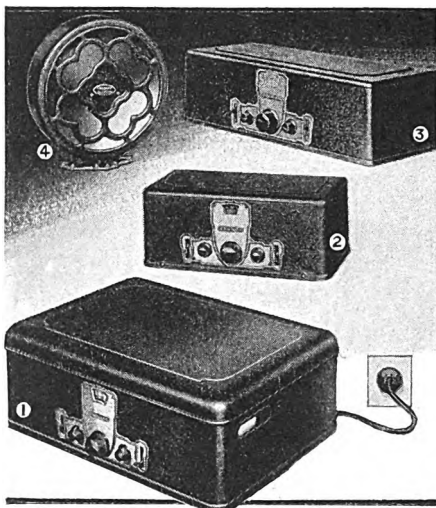
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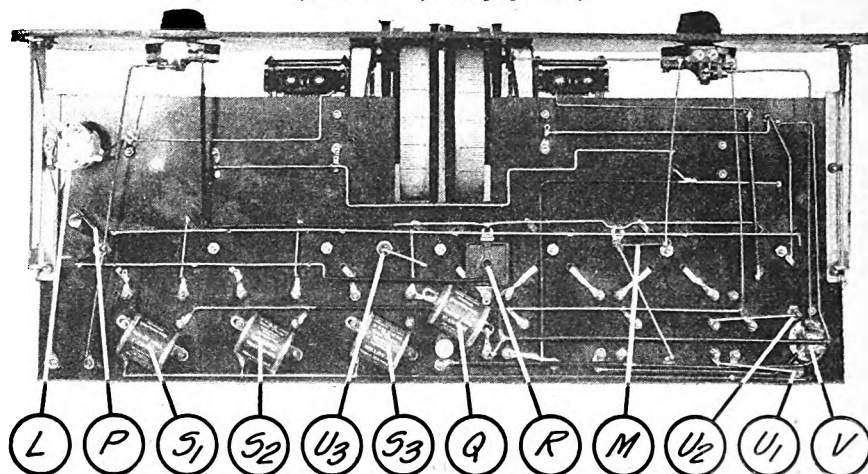
RADIO

Statement of the ownership, management, circulation, etc., required by the act of Congress of August 24, 1912, of POPULAR RADIO, published monthly at New York, N. Y., for April 1st, 1923, State of New York, County of New York.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Douglas H. Cooke, who, having been duly sworn according to law, deposes and says that he is the Publisher of the POPULAR RADIO and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Douglas H. Cooke, 119 West 57th Street, New York City, N. Y.; Editor, Raymond F. Yates, 119 West 57th Street, New York City, N. Y.; Managing Editor, Charles L. Davis, 119 West 57th Street, New York City, N. Y.; Business Manager, E. A. Harun, 119 West 57th Street, New York City, N. Y. 2. That the owner is: POPULAR RADIO, Inc., whose stockholders are: Douglas H. Cooke, 119 West 57th Street, New York City, N. Y.; Laurence M. Cockaday, 119 West 57th Street, New York City, N. Y.; Theodora W. Cooke, 59 Beechmont Drive, New Rochelle, N. Y.; Charles C. Moore, 345 Madison Ave. New York City, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are, NONE. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. Douglas H. Cooke, Publisher. Sworn to and subscribed before me this 20th day of March, 1923. Gerard J. Traub, Notary Public, Queens County. (My commission expires March 30, 1929.)

Here's a Superheterodyne with Screen Grid Valves

(Continued from page 374)



THE UNDER SIDE OF THE SUB-PANEL

FIGURE 5: This view gives an idea of the simplicity of the wiring of the set—a very remarkable job for a superheterodyne. No wiring is done above the sub-panel.

and third screen grid valves, should then be placed in position. Figure 2 shows the fixed resistances that are in series with this last mentioned rheostat and that are incorporated within the impedances themselves.

In wiring the receiver, it is recommended that every precaution be taken to follow the wiring diagram *exactly* as shown in Figure 2, using preferably the Acme celatsite. Make sure that all connections are tight and rigid, and in the instances where nuts are used, that they are all tightened down securely.

Upon the completion of the wiring, it would be advisable to check the completed receiver against both the schematic wiring diagram in Figure 4 and the picture wiring diagram in Figure 2.

The Operation of the Tyrman "70"

In placing the Tyrman "70" in operation, place three CeCo screen grid valves in sockets I1, I2 and I3, a Zetka Z-200-a valve in sockets I4 and I5, and a Zetka type Z-171 in socket I6. The oscillator valve, in socket II7, of the Zetka ZP-201-a type. It is necessary to connect the binding posts of the three screen grid valves in back of the second detector to the ground binding post. The Electrad socket antenna should then be connected to binding post T1. T2 is connected to the ground. T3 is the positive binding post of the 4½ volt "C" battery. T4 connects with the 3-volt negative-post on the 4½-volt "C" battery. T5 connects with the negative terminal of the 22½-volt Burgess "C" battery, which is in series with the

4½-volt "C" battery. The Knapp "A" supply positive (+) is connected to the red lead of the Yaxley cable. The negative (—) "A" of the Knapp supply connects with the black lead of this same cable. The "B" battery supply, consisting of three 45-volt Burgess "B" batteries, in series are connected up as follows: The negative (—) lead is connected to the yellow wire of the Yaxley cable; the blue lead of the Yaxley cable is connected to the 67½-volt positive (+); the brown wire is connected to the 90-volt "B" positive (+), and the green wire to the 135-volt "B" positive (+). All these connections are shown graphically in Figure 3.

The Browning-Drake reproducer is connected to the receiver by means of Gavitt extension cord.

It would, perhaps, be well to insert each valve in the socket *after* the batteries have been connected, so as to make sure that no damage will ensue due to defective wiring. In the event that in congested districts it is found that scarcely enough selectivity exists, this may be remedied very simply by the use of a short wire, eight or ten feet long, as an antenna instead of the socket antenna previously referred to. Under favorable conditions the distance possibilities of this set are very great.

It will be necessary to tune very slowly, and both dials should be rotated simultaneously. They should approximate within ten degrees the setting of each other. Volume is controlled through the regulation of the rheostat, N and O.

Pictures by Radio

The Rayfoto apparatus for receiving pictures by radio will be described next month in
POPULAR RADIO

“—in all DC sets where the amplification per stage in the radio frequency is low, they can be used to great advantage.”

Increased Amplification by simple change in valves

This new 6-volt amplifying valve is the latest production of Harold P. Donle, inventor of the already-famous sodion detector valve.

The Donle-Bristol DA-2 has a new type of oxide-coated filament, producing a much higher emission. It is used successfully in the high frequency amplifier of any standard DC set, *with no changes of any kind in the circuit.*

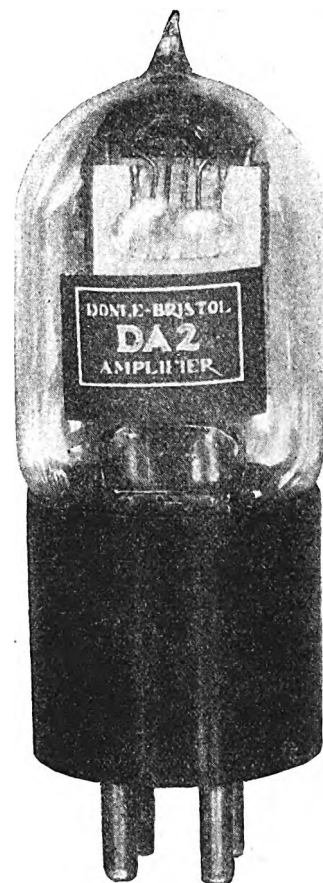
Each valve used increases the amplification from 30 to 50%—a gain at least equal to that which would be secured by an additional radio stage.

Le Clair's Radio Shop of Peekskill, New York, writes on March 9, 1928:

“We are in receipt of four Donle-Bristol DA-2 amplifier tubes. We have made many different tests and find that the tube is all that is claimed for it.

“The only objection we could find is that due to the great amplification the local interference is much more noticeable. However, in all sets where the amplification per stage in the radio frequency is low; they can be used to great advantage. The increase in volume in some circuits is even greater than half.”—Le Clair's.

Complete characteristics will be mailed upon request, and if your dealer has not yet secured his stock, mail orders will be promptly filled by the manufacturers.



*Exact size photograph of the new Donle-Bristol DA-2 Amplifying Valve.
Price \$3.00 each*

THE DONLE-BRISTOL CORPORATION
MERIDEN, CONNECTICUT

We are also manufacturers of high quality special-duty tubes and valves of all types and shall be glad to quote on your requirements

Victoreen A.C. CIRCUIT

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If you are interested in the construction of the most remarkable receiver of the year, by all means send for this new blue print. It supplies detailed information by which anyone can build the Victoreen A.C. Super.

Unsurpassed selectivity, sensitivity and tone quality is due to the famous

Victoreen R. F. Transformers

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Victoreen "112" Audio Unit combines two stages in the one case. Produces marvelous tone quality. Price \$22.00.

New Victoreen Filament Transformer, for use in the A.C. Set. Price, \$22.00.

New Victoreen Switch and Plug Unit—for use in the A.C. Set. Price, \$4.75.

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New York City

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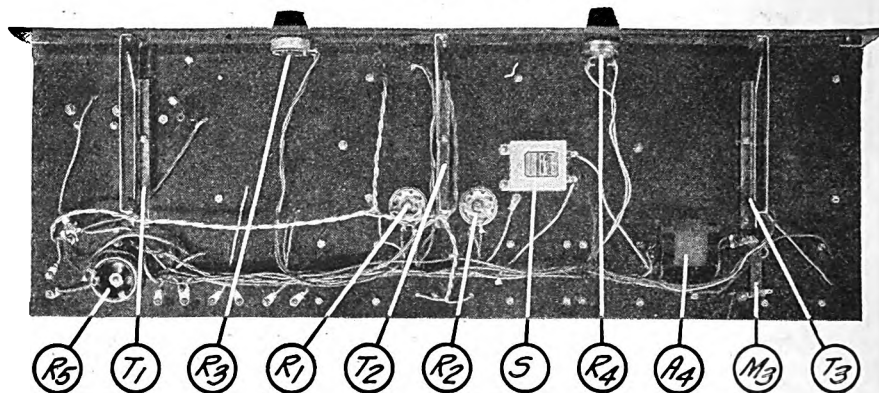
Name

Address

City..... State.....

Building the QSA-5

(Continued from page 369)



THE UNDER SIDE OF THE RECEIVER

FIGURE 5: This view shows the proper method of cabling the wiring, and the placement of the parts mounted under the sub-panel.

resistances, Q1 and Q2. The Centralab heavy duty potentiometer, R5, should then be connected as shown in Figure 2. Upon completion of your wiring, carefully check for errors, loose connections and forgotten wires.

How to Hook Up the Receiver

After the wiring has been completed, a Raytheon type BH rectifier valve should be inserted in socket L6. Three Ceco RF 22 screen grid valves should be inserted in sockets L1, L2 and L4, a Ceco type H valve in socket L3, and a Ceco type J-71 valve in socket L5. The ground wire should then be fastened to the proper binding post as shown in Figure 3. The photo-diagram also shows the proper connections for the SPN reproducer, which should be located at some distance from the receiver, and the Knapp "A" power unit. Make sure that a sufficiently low tap on the "A" supply unit is used to insure the valves against too high a filament voltage. The Thordarson compact, I, and the Knapp "A" power unit may be connected to the lighting lines and turned "on." The set should now

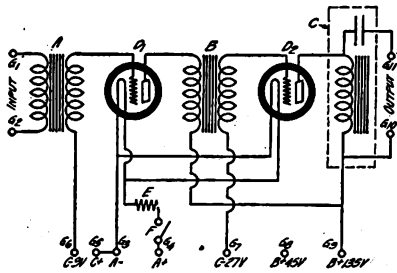
be in operation. Tuning is controlled by the double drum dial, B. Volume is controlled by the Clarostat unit, R4. The rheostat, R2, is an adjustment for maximum voltage on the filaments of the screen grid valves and R3 is a filament control used in conjunction with the latter rheostat. It is important to adjust the 5,000-ohm Centralab potentiometer, R5, to its best point so that proper "B" voltage may be applied to the screen grid valves. A little aural experimentation will suffice to determine this voltage. It will be found that, due to the great amplification obtainable with the receiver, excellent results on most stations will be had with the volume control only partly advanced. As to distance possibilities, an advance model of the receiver, operating 15 miles from the center of Chicago, brought in stations within the radius of a circle bounded by New York, Havana, San Antonio, Los Angeles and Oakland, California. It was also able to get WEAf clearly through the signals of WCFL in Chicago, and WJZ through the signals of the local station WMAQ.

More Data on Television

The continued research of the POPULAR RADIO AND TELEVISION Laboratory in the use of simple television apparatus will be featured next month in this magazine. This is an opportunity for every experimenter and fan to enter this absorbing field at the very beginning. Don't wait for the rush—get the June number of POPULAR RADIO AND TELEVISION.

The National Screen Grid Tuner

(Continued from page 396)



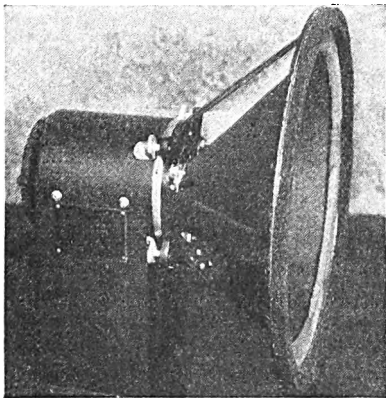
THE CIRCUIT OF THE AMPLIFIER
FIGURE 5: The wiring of the Karas low-frequency amplifier may be ascertained from this diagram. The mounting of the parts is shown in Figure 3.

extent while increasing sensitivity to a marked degree. The lower left dial which controls the filament of the screen grid valve should be kept turned down as far as possible consistent with good quality and the desired signal intensity. This will help considerably to prolong the life of the screen grid valve. The total absence of lost motion and the smooth and positive action of the drum dial will prove a revelation to the most critical. While this set may be small its distance possibilities are very large.

Figure 3 shows very plainly the Belden cable connections to the various parts which supply the "A" and "B" current for this set. The Electrad socket antenna will supply sufficient radio energy for average needs.

Dynamic Speakers

(Continued from page 366)



THE JENSEN SPEAKER WITH CABINET REMOVED

nected directly to the output of a receiver.

The Jensen speaker comes mounted in a highly-polished cabinet measuring 14 by 16 by 12 inches, which also serves as a baffle board. When the units are ordered without the cabinet, some baffle system must be provided.

The response curve of the Jensen is particularly gratifying, responding to frequencies as low as 40 cycles and as high as 10,000.

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presents An Amazing

New
Circuit
for Screen
Grid Tubes!



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screen grid 5

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RIGHT today you can have the kind of reception you may get six months from now. In the HARK-

Amazing Selectivity!
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Cuts right thru locals—gets Distance on Loudspeaker!
Costs Less to build than Ordinary 5-tube set!

builders' hands it cut through the barrage of local and suburban stations and created new distance records at all hours.

NESS Screen Grid Five Kenneth Harkness gives you the results that other engineers are still trying to get with the new Type 222 Screen Grid Tube. He has solved the problem of obtaining sharp selectivity with Screen Grid Tubes at the same time retaining high amplification. Oscillation is positively and unfaillingly controlled.

The set is so selective and so sensitive that it tunes through locals in the most congested districts getting distance on the loudspeaker. Under the most unfavorable conditions in the heart of downtown New York a HARKNESS Screen Grid Five logged 31 distant stations in one evening between 7 and 10 P. M.

Won New York In One Week

Its amazing performance made the HARKNESS Screen Grid Five New York's most popular and largest selling kit in ONE short week. Its success was sensational—overwhelming. In

No Other Set To Equal This

Tube for tube and dollar for dollar no set can be compared with the HARKNESS Screen Grid Five as a DISTANCE getter. It is in a class entirely alone, as was the Harkness Reflex in its time.

Simple to assemble and operate; single dial control perfectly balanced.

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Just write your name and address on the Coupon and mail TODAY. Be first in your community to get the facts about this sensational set. Or order a kit on our unconditional GUARANTEE of satisfactory D.X. But do not turn this page until you have filled in and sent the coupon.

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Radio Engineers and Designers
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New York City

Without cost or obligation, RUSH to me details of your new sensational set, the HARKNESS Screen Grid 5.

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Dealers and Set Builders: Wholesale prices quoted if attached to your business letterhead.

Protect A. C. Tube Filaments from Excessive Line Voltages

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Resistors and Rheostats

High line voltage limits the life and effectiveness of A. C. tubes.

Eliminate once and for all the annoyance and expense of replacing A. C. tubes ruined by excessive line voltage. The cost is small.

Send to-day for complete information. It costs you nothing to check up on line voltage and make certain that your A. C. set is operating within safe limits.

Just ask for Circular 512. It will be sent without charge.

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Offers finest, new-
est well-known sets;
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accessories at lowest
prices.

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Write for this
Catalog!

**Western Radio
Manufacturing Company**

136 West Lake St. Dept. 55
CHICAGO, ILL.

The Onward March of Radiovision

(Continued from page 371)

to that cell. No television transmission demonstration has ever been made, as yet, in which the subject could be placed more than a few feet from the scanning apparatus. Facilities are still limited to sending a single face or a simple object. Where reasonable detail has been attained, as with the system of Alexanderson and that of Bell Laboratories demonstrated by Ives, short waves and several channels were required, so as to increase the number of images handled. To have reproduced Alexanderson's demonstration on the present broadcast band would have necessitated the simultaneous and coordinated use of four broadcasting stations and at the receiving end of four receiving sets.

Television on the broadcasting band, employing a single station, is constrained to the transmission of an image which can be reproduced with but 312 picture impressions, the maximum which can be transmitted with 5,000-cycle modulation. This is roughly a picture one inch square of 17 screen, or 17 dots per linear inch. Pictures in newspapers are of 55 screen and in this magazine, 110 screen.

Television, in order to attain perfection, must be able to thousandfold the capacity of present systems—a task of tremendous magnitude. The screen must go up to at least 50, or 2,500 dots per square inch, and the size of the picture to at least four by five inches, making necessary the transmission of 50,000 impressions each sixteenth of a second. That entails an available modulating frequency of about a million cycles. Present limitation to 5,000 cycle modulation accounts for the very crude results obtained with shadow-graph machines.

With such a system as Cooley's, on the other hand, introduction of photographic processes both in transmission and reception overcomes all of these limitations. The camera at the transmitting end does the work of collecting the images involved, however extensive their area, on a single sheet of photographic paper. Scanning is, therefore, readily accomplished without reflecting lights from subjects confined to a few inches of area.

At the receiving end, photographic processes likewise make it possible to overcome the limitations of ether channels. As much time as is wanted can be taken to transmit a single picture, instead of being limited to a sixteenth of a second, because the photographic paper at the recorder collects images over any desired period. With the Cooley system, for example, a received 4 by 5 picture consists of more than 100,000 image impressions. Mod-

ulation of 800 cycles is employed, taking fullest advantage of the capacity of the average receiving set for faithful reproduction. There is no comparison between the program value of a moving picture of 312 impressions with a permanently recorded still picture of 100,000 impressions. In one case, the result is a bare silhouette, and in the latter, a news picture of better grade than appears in the daily press.

The first regular broadcasting of radio photographs was undertaken by WOR, of L. Bamberger & Company, Newark, N. J., using the Cooley Rayfoto system. This system is unique in that it employs a corona discharge for making the photographic print. The corona discharge is obtained by the use of a single vacuum valve. Its light is ultra-violet and blue purple, which most readily affects photographic paper and makes possible the use of insensitive and inexpensive papers. No special dark rooms are required because the paper is not highly responsive to strong light. Furthermore, the corona is sprayed directly on the paper itself, involving no lenses, mirrors or moving parts and thereby greatly increasing the available light. These features account for the simplicity, economy and low initial cost of the Cooley system.

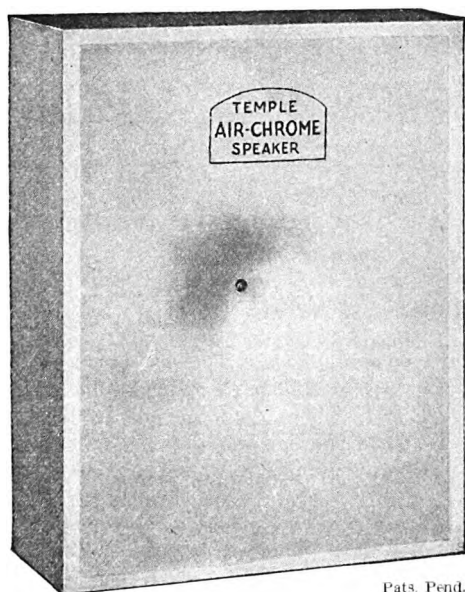
To receive Cooley pictures, any good broadcast receiver may be used. The output of its two-stage low-frequency amplifier is supplied to an amplifier-oscillator unit, which changes the picture signal into a high-frequency modulated current suitable for radiation as corona discharge. This two-valve unit is no more difficult to build than a two-valve radio receiver. The first valve acts as an amplifier-rectifier, the output of which modulates that of the second valve, which is a high-frequency oscillator of the Hartley type. The oscillating circuit is the tuned primary of a Tesla coil. The high voltage end of this Tesla or corona coil is connected with a needle on the printer unit.

The printer unit consists essentially of a revolving drum, a corona needle holder, the movement of which is actuated by a finely threaded shaft across the surface of the paper, a clutch mechanism and a trip magnet for accomplishing synchronization. Any good phonograph may be used as a power source for the printer unit. The printer unit is a precision instrument, in that its functioning determines the correct placing upon the photographic paper of the 100,000 odd picture impressions.

It can be seen from this brief description that the Cooley Rayfoto system is a thoroughly simple, thoroughly practical method of receiving broadcast pictures by radio.

TEMPLE

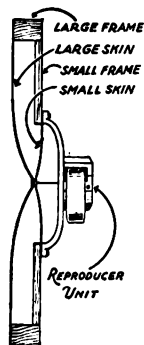
The New Temple Air-Chrome Speaker



Pats. Pend.

Model F. Note the simple and sturdy construction. The straight lines make for easy installation. Temple Air-Chrome Speakers are licensed under the Whitmore inventions.

The "How" and "Why" of the Temple Air-Chrome



The Air-Chrome principle, while it is new, is so logical that the efficiency of this type of construction is readily appreciated. In Air-Chrome construction, two tightly stretched skins, chemically treated, form the diaphragm. This diaphragm is so arranged that the large front half is tuned to the lower frequencies and the smaller or back half to the higher frequencies. Both halves are balanced at the center. At this balanced center the driving unit operates and as there is no dead weight to overcome because of the balanced feature it is easy to understand how the slightest impulse on the driving unit is instantly transmitted to the taut diaphragm. The result is a

sensitivity, a frequency response and a handling capacity in undistorted volume that is a revelation in speaker design.

THE Temple Air-Chrome represents one of the most startling speaker developments that the industry has ever seen. It couples Temple engineering and experience in speaker manufacturing with one of the most advanced principles ever developed in sound reproduction and at the same time carries with it more of the essentials demanded by set builders than any speaker developed up to this time.

The Temple Air-Chrome is of the open radiator type. Its diaphragm is so arranged that the larger front half is tuned to the lower frequencies and the smaller, or back half, to the higher frequencies. This type of construction makes possible the balanced tension principle whereby the slight-est impulse is carried from the driving unit to the diaphragm without any loss. Lightness is combined with rigidity, climatic changes have no influence in that no paper is used, and the mechanical construction and design eliminates the inherent difficulties ordinarily met with in open radiator types.

Special Temple Double Action Unit Employed

The inherent factors of the Temple Air-Chrome, plus the performance of a specially developed powerful Temple Double Action Unit, accounts for its handling capacity—for its enormous volume—its brilliancy—its full response to all audible frequencies. That's why the Temple Air-Chrome will not chatter—why it is suited particularly to every kind of power output.

Three Standard Sizes:

Model K	Model J	Model F
14" x 14"	24" x 24"	18" x 23"
\$20.00	\$25.00	\$23.00

All Light in Weight

As can be seen from the illustration, Temple Air-Chrome speakers are plain but business-like in appearance. The square or rectangular frames not only offer maximum protection for the entire unit, but makes possible an ease of installation which set builders will appreciate. The three standard sizes lend themselves to a multitude of cabinets or console designs.

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AMPERITE is the only automatic filament control that keeps the temperature or voltage of the tube filament constant despite variations in the "A" battery voltage. It guarantees improved tube performance and increased tube life through always operating tubes at their proper filament temperature. Simplifies wiring, panel design, tube control, tuning. Eliminates hand rheostats. Do not confuse with fixed filament resistors which attempt to imitate **AMPERITE** but are entirely different in principle and operation. Insist upon *Amperite*. Price \$1.10 mounted (in U.S.A.) For sale by all dealers.

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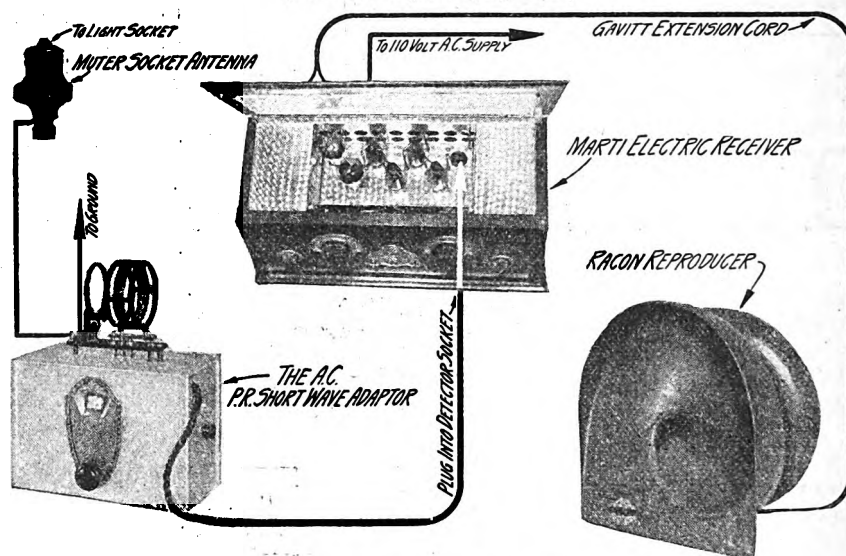
Details sent on request.

Radio  Service

Radio Technical Masters, Inc.
136 Liberty Street, New York

A Short-Wave Converter for AC Receivers

(Continued from page 393)



THE OPERATING HOOK-UP

FIGURE 3: The connection between the converter and the broadcast receiver (Marti Electric illustrated) is made with a plug made from a burnt-out five-prong socket.

fastened to the right-hand side panel by means of machine screws and nuts. Two spacing washers approximately $\frac{1}{4}$ inch thick should be inserted between this instrument and the panel. Drill a hole $\frac{3}{8}$ inch in diameter in the upper left-hand corner of this panel for passing through the twisted leads of the connector plug.

How the Converter is Wired

The wiring details and the proper positions of the instruments are shown in Figure 2. The coil assembly, A, which is mounted on top of the box shield, is shown in dotted black lines. The instruments that are mounted within the box shield, I, are outlined in solid black lines. Wiring done inside the shield is shown in solid red lines, and that done outside the shield in dotted red lines. The instruments are outlined in black.

In making the wiring connections on this unit it is recommended that the constructor use insulated wire such as Corwico rubber covered hook-up wire.

When the wiring has been completed, each lead should be re-checked with the picture wiring diagram in Figure 2. After this has been completed the grid-leak, G, is inserted in the grid-leak clips,

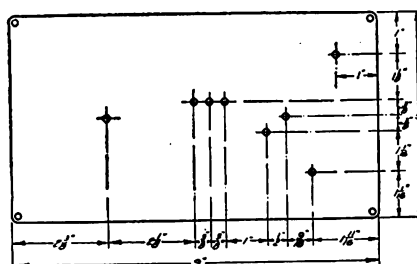


FIGURE 4: THE DRILLING PLAN
FOR PANEL 12

and the short-wave converter is then ready for connecting to the broadcast receiver.

How to Operate the Short-Wave AC Converter

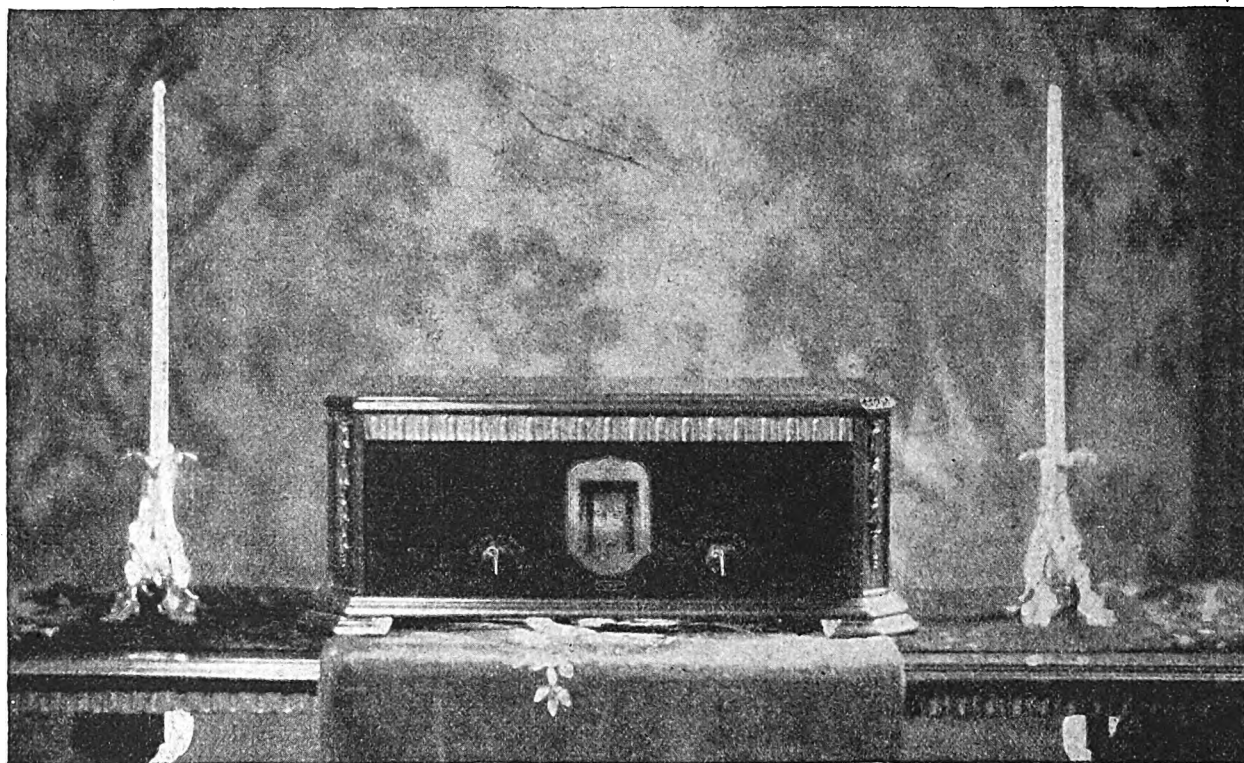
Disconnect the antenna and ground connections from the Marti electric set, or any standard broadcast receiver using AC valves. Attach these leads to the antenna and ground terminals of the AC Converter. Then insert the connector plug of the converter into the detector socket of the Marti electric set. The photo-diagram in Figure 3 shows all the connections to be made between the receiver, the Racon reproducer, the Muter light-socket antenna and the short-wave AC Converter.

The broadcast receiver may be restored to its original use for reception on the regular broadcast band by simply disengaging the connector plug and replacing the detector valve in its socket in the broadcast receiver.

A long or short antenna may be used for short-wave reception. If a long antenna is used, the primary of the coil assembly, A, should be loosely coupled to the grid coil. The neutralizing condenser, H, which controls regeneration, should be adjusted for best reception at each particular station received.

When receiving continuous wave code signals it will be necessary to have the converter in an oscillating state. It should be kept just below the point of oscillation for broadcast reception.

It is recommended that a record be kept of the dial setting and the size of the coil used for all stations received. This complete data should be kept so that the station may be tuned in again by referring to it.



The New Improved Hi-Q Six—the creation of ten foremost American Radio Engineers—a receiving instrument that is far in advance of its time.

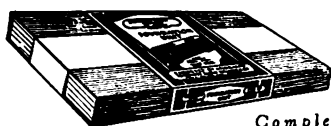
Exclusively CUSTOM-BUILT By Yourself at Home . . . from our Simple Instructions . . . and at Great Savings!

No ordinary standards can be applied to this latest improved Hammarlund-Roberts Receiver, for it is the result of a determination to produce America's very finest instrument—absolutely regardless of cost!

Every modern constructional feature has been incorporated. Each part is the most efficient known to radio science, and the entire group has been purposely selected for perfect synchronization. Complete isolation of four tuned circuits plus Automatic Variable Coupling effects maximum and uniform amplification over the entire wave band. Distortion is totally eliminated. Oscillation is utterly absent. Symphonic transformers and a power tube

faithfully reproduce the full musical scale. Selectivity, even in crowded areas, is something to marvel at. And tonal quality simply **MUST** be heard to be appreciated!

Such a set, factory made, and sold through usual channels, would possibly cost around \$300.00, but, through following our simple instructions, you can purchase all parts for only \$95.80 and build this supreme receiver yourself—a **CUSTOM BUILT** set which gives you **CUSTOM BUILT** results at a saving of \$100 to \$150. Get the complete Hi-Q Instruction Book from your dealer—or write us direct. Price 25 cents.



Completely drilled panel and sub-panel are foundation for easy building.

Hammarlund ROBERTS Hi-Q SIX

HAMMARLUND-ROBERTS INC.

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Associate Manufacturers





Audio Frequency Transformers

for the
best in audio amplification
—and there is a Ferranti for
every requirement

Having available the best in audio amplification, the next step is to apply the transformers to the best advantage.

The 1928 Ferranti Year Book just off the press contains 64 pages of useful information, including instructions for building radio sets and power amplifiers, with special treatise on the use of audio transformers in receivers and cures for motor boating.

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The Victoreen Socket "Super"

(Continued from page 385)

hand terminal, F, of socket E5, continue this wire to the right-hand terminal of socket E6, from there to the right-hand terminal, F, of socket E7, from there to left terminal of condenser P1, where we leave a lead of approximately seven inches projecting from condenser P1.

Now place the filament lighting transformer, F, in position and fasten it down, as shown in Figure 1. The twisted leads coming from the right side of this filament transformer, and marked 5 volts, should be run to the two filament leads of socket E8. The 2½-volt winding which issues from the right side of transformer, F, should then be led to the terminals, HH, of socket E3, and to the terminals, HH, of socket E4, as shown in the diagram in Figure 2. The 2½-volt winding which issues from the left-hand corner of the filament lighting transformer, F, should be led to socket E2, and fastened to the terminals, HH. These two leads should continue to terminals HH of socket E1. One of the 1½-volt leads issuing from the left-hand of filament transformer F, should be led to the right-hand terminal, F, of socket E5.

The front panel may now be placed in position and screwed to the baseboard.

The remaining 1½-volt wire that issues from the left-hand terminal of filament transformer F should be fastened to the right-hand terminal of the ½-ohm rheostat, H. The center terminal of this rheostat should then be connected to the left-hand terminal, F, of socket, E5. The two seven-inch leads running from condensers P1 and P2 should then be fastened to the two outside terminals of the 30-ohm potentiometer, I. The center terminal on this 30-ohm potentiometer, I, should then be connected to the right-hand terminals of condensers P1 and P2. A wire should be run from the left-hand terminal of potentiometer J to the left-hand terminal of condenser Q. The center terminal of potentiometer J should be connected to the upper terminal of the intermediate transformer, C3, which is nearest the socket, and also to the corresponding terminals of transformers C2 and C1. Run a wire from the right-hand terminal of potentiometer J to the right-hand terminal of condenser Q, and from there to the near terminal of condenser P3.

Take the lead which issues from the transformer F, which is marked 5-volt center-tap, and connect it with the right-hand terminal of condenser Q.

Run a wire from the rotor of condenser D1 to the second lug (counting from the top) of the switch, K, and continue this wire to the left-hand side of the oscillator coil, B. Connect the

stator of the condenser, D1, with the fifth lug of the switch, K, and continue this wire to the unused terminal of grid condenser N1. Terminal 1 of switch K should now be connected to the upper terminal of the antenna coupler A, which is nearest socket E1. The third terminal of the switch should have a wire connected with it, running to loop terminal binding post V4. The fourth terminal should be connected to the lower terminal of antenna coupler A, which is nearest socket E1. The sixth terminal should be connected to the binding post, V3. The antenna binding post, V1, should be connected to the lower terminal of the antenna coupler, A, which is nearest the rear of the baseboard. Binding post V2 should be connected to the upper terminal of antenna coupler A, which is nearest the rear of baseboard.

From terminal K of socket E1 we run a wire to the upper left-hand side of the oscillator coil, B. The lower left-hand terminal of this same unit, B, is run to G on socket E2, thence to the rotor of the variable condenser, D2. From the stator of the variable condenser, D2, run a wire to the terminal P of socket E2. From there this wire continues to the lower right-hand terminal of the oscillator coil, B. A wire is next connected to the upper right-hand terminal of the oscillator coil, B, and is run to the terminal which is nearest the rear of the baseboard of the grid-leak, R2, then to the upper left terminals of the intermediate-frequency transformers, C1, C2, C3 and C4. This same wire continues to the 1 mfd. condenser, P3, and is connected to the terminal nearest rear of baseboard. This wire should extend several inches beyond this point.

The binding post strip, U2, may now be temporarily placed in position. As the connections to this binding post strip are beneath the strip, it is not advisable to bind it down for the present. We will now continue with the wire from the terminal of condenser P3 to the lug of the binding post, V6. The lug of the binding post, V5, should now be connected to the condenser, P3, at the nearest terminal, and then continued to the binding post, V11. Run a wire from P of socket E1 to the lower left terminal of high-frequency transformer C1. Connect a wire between G of socket E5 and the lower right terminal of high-frequency transformer C1. Connect a wire to P of socket E5, and run this wire to the lower left terminal of high-frequency transformer C2. A short wire is now connected between G of socket E6 and the lower right terminal of high-frequency transformer C2. Connect P of socket E6 with the lower left

terminal of high-frequency transformer C3. Another short wire connects G of socket E7 with the lower right terminal of high-frequency transformer C3. Next connect a wire with P of socket E7 and the lower left terminal of high-frequency transformer C4. Connect a short wire between the grid condenser, N2, and the lower right terminal of high-frequency transformer C4.

Connecting a wire with terminal P of socket E3, we connect this wire to the lug of terminal P of section G1 of the low-frequency transformer. This wire continues to one terminal of the .005 mfd. condenser, T. From the other terminal of this same condenser we solder a wire which is fastened to the lug of the "B" positive (+) terminal of the unit, G1, and continue this wire to the binding post, V6. A short lead is now connected to terminal G of socket E4, and to G of unit G1. Another short wire connects terminal P of socket E4 with P of unit G2. Continuing to the last low-frequency stage, we connect terminal G of socket E8 with G of unit G2. Solder a wire to P of socket E8, and continue this wire to binding post V13.

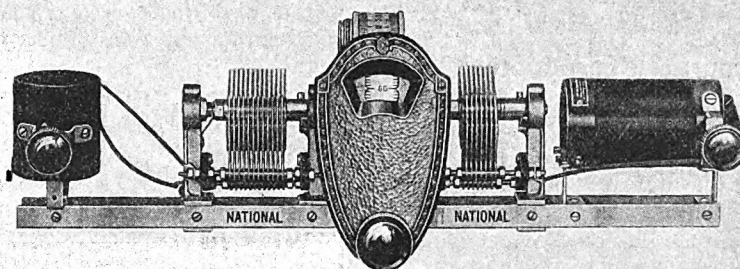
Solder a wire from the "C" negative (—) terminal of unit G1 to binding post V9. Fasten a lead from the "B" positive (+) terminal of unit G2 to binding post V10. Solder a lead from the "C" negative (—) terminal of unit G2 to the binding post, V12. A short lead should now connect the lugs of binding posts V7 and V8. Solder a wire to terminal A of coupler B, and connect this wire to the two inner terminals of the grid-leak mountings, R1 and R2. Continue this same wire to condenser P4, and from there the same wire is continued to the upper right-hand terminal of the intermediate-frequency transformer, C4. Connect the wire which issues from transformer F, and is marked $2\frac{1}{2}$ -volt center-tap, to the upper left-hand terminal of intermediate-frequency transformer C2.

The Victoreen unit M should now be fastened to the baseboard with two screws, and the binding post strip, U2, may now be fastened in position by means of the bracket supports.

The switch, L, should now be placed in position on the panel and fastened by means of the threaded round nut. This completes the assembly and wiring of the AC Victoreen superheterodyne.

Constant reference should be made to the picture wiring diagram in Figure 2 to check the wiring as it proceeds, followed by a final recheck after completion.

In the next issue of POPULAR RADIO will appear complete details for operating the receiver, as well as constructional data for the "B" power-pack designed to work in conjunction with it.



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Quoting Volney D. Hurd, Radio Editor of the Christian Science Monitor of Boston, in an article published March 7, 1928:

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NATIONAL 7180 B

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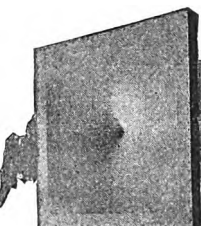
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33 YEARS OF PRECISION
MANUFACTURE

A New Way to Quality Reproduction With the Samson Amplifier

(Continued from page 398)

"B" voltages supplied to the set) and its quality or reproduction, due to the large amount of power that is available without distortion and the high quality of the coupling transformers in the unit.

Of course, it should be used with a modern type of reproducer to get the best results.

The picture wiring diagram for this receiver is shown in Figure 3, and it contains complete details of construction and wiring so that any set builder will be able to build it and get the expected results, if the directions are carefully followed out.

How to Assemble the Unit

To start building the Samson amplifier, first cut the baseboard, H, to the proper size, 12 by 17 by $\frac{3}{4}$ inch, as shown in Figure 2. It should be smoothly sandpapered and given a coat of stain and shellac.

Then prepare the binding post strip, I, as shown in Figure 2. The ten binding posts, K1 to K10, should be attached to this strip. The first two binding posts, K1 and K2, are the input connections to the receiver with which the amplifier is to be used. Binding posts K3, K4 and K5 are the "B" battery positive (+) terminals and K6 is the negative (—) "B" battery terminal. The $4\frac{1}{2}$ -volt "C" negative (—) terminal is K7 and the 9-volt "C" negative (—) terminal is K8. The reproducer should be connected to the output terminals, K9 and K10.

The binding post strip may then be fastened near the edge of the baseboard, H, as shown in Figure 2, by means of two wood screws and two pieces of $\frac{1}{2}$ -inch metal tubing which serve as mountings for this binding post strip.

After all the instruments have been secured, the parts should be mounted on the baseboard, H. The power block, A, and the condenser block, B, should be mounted, side by side, in the positions shown in Figure 2. Then the four sockets, J1, J2, J3 and J4, should be mounted in position by means of two wood screws each. Next the two tapped resistors, E and F, should be fixed in position by means of wood screws at each end of the resistors.

The next job will be to mount the input transformer, C, in position with wood screws. Fasten the output impedance, D, on the right-hand end of the baseboard, as shown in Figure 2. Then make a brass angle to hold the variable resistor, G. Be sure that the mounting brackets on the variable resistor, G, do not touch the metal case or brackets of the other instruments.

This completes the construction work

except for the four rubber feet to be attached to the baseboard.

How to Wire the Samson Amplifier

It is recommended that all wiring on this unit be done with Gavitt rubber-covered hook-up wire. Refer constantly to the picture wiring diagram in Figure 3 in making connections. The wiring above the baseboard is shown in solid blue lines and that below the baseboard in dotted blue lines. The position of the holes to be drilled in running the wires from the top of the baseboard to the bottom of the baseboard are indicated by black circles.

How to Install the Unit

The unit may be placed in the radio compartment of the console or radio cabinet or the receiver with which it is to be used. In the photo-diagram in Figure 1 the unit is shown in use with the Hammarlund-Lynch "5" receiver. Make the connections between the receiver and the power-pack amplifier as indicated in Figure 1. This diagram is complete and shows the connections to the S. P. N. reproducer, the Exide "A" battery and the Yaxley relay. By referring to this diagram, it will be noticed that the second input binding post of the amplifier is connected over to the 135-volt "B" positive (+) binding post.

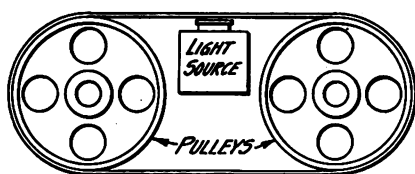
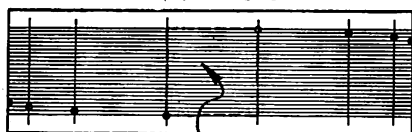
Looking at the front of the Hammarlund-Lynch "5" Receiver, remove the two Lynch fixed resistors and the Lynch coupling condenser from their mounting clips in the rear left-hand corner of the sub-panel. This is the third resistance-coupled stage of the amplifier. The combination diagram, Figure 1, shows a separate lead which should be soldered to the right-hand mounting clip that formerly held the Lynch coupling condenser. This new lead should be connected to the input terminal, K1, of the power-pack amplifier.

It is recommended that a new Donle R. F. DA-2 valve be placed in the high-frequency stage of the Hammarlund-Lynch "5" Receiver; a Zetka ZD valve in the detector socket, and two Zetka ZAF valves in the first and second resistance-coupled stages in the Hammarlund-Lynch "5" Receiver. For the amplifier, place a CX-380 rectifying valve in socket J1; a CX-374 regulator valve in socket J2; and two CX-371 valves in sockets J3 and J4.

When the connections between the receiver and the power-pack amplifier have been completed, the special plug that comes with the power block, A, should be inserted in the power block. Figures stamped on the sides of the plug indicate which side should face upward when the unit is to be operated from line voltages of 110, 115 or 120.

Scanning Devices

(Continued from page 390)



A SCANNING BELT

FIGURE 2: In this sort of scanning device the holes are arranged diagonally on a belt which passes over two wheels, one of which supplies the driving force. The image is defined by the distance between holes, and the combined width of the holes.

metals that could be used. It is easy to drill and machine and, owing to its light weight, it is least affected by the high speeds necessary in scanning work. Thin sheets of metal with a slight warp in them will have a tendency to flatten out when revolving at high speed.

Having acquainted ourselves with the mechanical operations necessary for the production of the scanning disc, we are now ready to review the factors determining the physical dimensions of the disc and the laying out of the holes. It is evident that the larger the number of holes on the disc, the greater the tendency toward better reproduction. The number of holes in the disc determine the number of sections or lines into which the picture is divided. Thirty-six holes would simply mean that the picture was divided into 36 sections or lines.

What actually determines the size of the picture that can be transmitted is the distance between the holes, as well as the size and number of the holes. This becomes clear upon reference to Figure 1. From this diagram it will also be plain that the size of the picture must be adjusted so that only one hole is sweeping across it at one time. Simple arithmetic will show that the scanning disc is more or less limited in its application, and that home experimenters cannot hope to transmit very large pictures with great detail.

Although scanning wheels or discs provide what is perhaps the best known method of illuminating objects to be transmitted, there are several other methods that have been applied successfully and which lend themselves to experimental research. Figure 2 shows how a moving belt, which may be of very thin metal, can be applied to the problem of scanning. Here the holes are arranged diagonally, producing the equivalent of a spiral. In this instance, the size of the picture is determined by the distance between two successive holes and the width of the belt.

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Radio Problems Solved

It is possible that your individual problem has been covered in an issue of POPULAR RADIO, and so as an aid to you we endeavor to keep a supply of back numbers in stock. The condensed index below gives a few of the subjects that have appeared recently; look this list over and if the information you want is covered, we will be pleased to supply back numbers at 35c a copy.

December 1927

The New AC Superheterodyne
1,000,000-Watt Broadcasting
Socket Power for Your Atwater Kent
If You Live in a Building with a Steel Frame Work
An Amazing Discovery in Resistance - Coupled Amplifiers

January 1928

The 1928 AC Browning-Drake
The AmerTran Amplifier and Power Pack
The Harkness Counter-fonic Six
Making Radio Pay
A New Discovery in Loudspeakers

February 1928

The Earth's Radio Roof
13 Features in the AC Equamatic
The Teletrol Wave Lifter
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Push-Pull for the Hi-Q

March 1928

And Now—An LC-28
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The Aero Converter
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I Used To Give Radio Information Away—Now I Sell It

POPULAR RADIO

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For the Modest Pocketbook—the LC-28 Junior

(Continued from page 380)

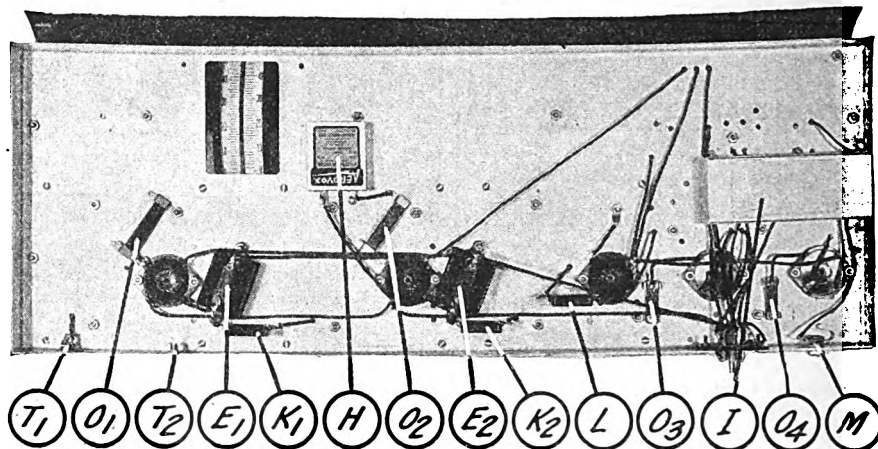


FIGURE 5: THE UNDER SIDE OF THE SUB-PANEL

more convenient in some circumstances. The ground wire is attached to the tip jack, T2. Next place two Cunningham CX-322 type valves in the sockets P1 and P2. In the detector socket, P3, place the new Carborundum stabilizing detector tube. Then place a Cunningham CX-301-a type valve in socket P4. In the last socket, P5, place a Cunningham CX-371-a type power valve.

The photo-diagram in Figure 3 shows the exact connections to be made between the various units.

Connect the two field leads on the Jensen Dynamic Reproducer to the "A" storage battery as shown in Figure 3.

The tuning of the antenna circuit is accomplished with the left hand knurled disc of the double drum dial, U. The two remaining stages are tuned with the right hand knurled disc of the drum dial, U. The rheostat, S, permits of zero to maximum control of volume.

The potentiometer "cap" at the top of the Carborundum stabilizer "tube" should be adjusted for best results.

If the set builder follows out exactly all the instructions, this receiver, with its screen grid valves, will provide a high order of amplification, excellent selectivity and a quality of reproduction which will be a pleasure to listen to.

The Harkness Screen Grid "5"

(Continued from page 388)

Antenna, ground and loudspeaker, as shown in the photo-diagram in Figure 4, the valves should be inserted one at a time and a station should be tuned in slightly below "50" on the dial. Very carefully and slowly adjust the three equalizers until maximum audibility is obtained. Continue turning down the volume control as you proceed so that you can more accurately tell whether

you are obtaining the correct adjustment. Check this adjustment on another station, preferably a distant one, to insure absolute resonance of the three tuned circuits at all positions of the tuning dial. After this procedure there will be no further need for these adjustments and tuning will be accomplished solely by the setting of the single control dial on the front panel.

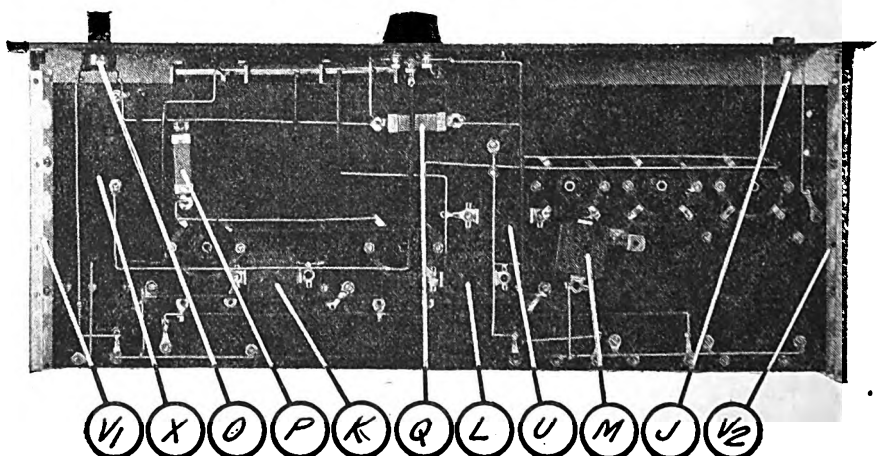


FIGURE 5: THE RECEIVER FROM BENEATH

What Is a Transmission Unit?

MODERN technical radio literature reveals the increasing use of the term transmission unit. Although this term is used a great deal, as yet there has been very little written describing its meaning and the mathematical justification for its existence.

Power is the rate of doing work. For instance, work must be done to light the ordinary electric light. We say the power consumed by the light is 25 watts or 100 watts, as the case may be.

Similarly in the radio set a small amount of low-frequency power is used in the primary circuit of the first low-frequency transformer, and a much larger amount of power with the same frequency or characteristics is used in actuating the loudspeaker.

The ratio of the output power of the amplifier to the input power may be expressed as

$$\frac{P_2}{P_1}$$

There has been a decided gain in power in this amplifier. In some other system there might be a decided loss.

A method of expressing gains and losses is desirable. The transmission unit (abbreviated TU in either singular or plural) was adopted by the Bell Telephone Laboratories in 1924 for the purpose of comparing powers at two points along a system, e.g., the above amplifier. The transmission unit was so chosen that when two powers have the ratio the number of transmission units gain or attenuation (loss) equals

$$N_{TU} = 10 \log \frac{P_2}{P_1}$$

One transmission unit represents about the least difference in the loudness which can be detected by the ear without special training.

The TU replaced the older unit called the "mile of standard cable," an arbitrary unit for measuring attenuation.

Some of the advantages of the transmission unit may be enumerated as follows:

1. It is logarithmic, and the ear also

hears in proportion to the logarithm of the sound power ratio.

2. It is distortionless, whereas the "mile of standard cable" had a different effect at various frequencies.

3. It is based on a power ratio, which has an advantage in that powers may be compared, even though they are being expended in different impedances. Also different types of power, such as sound powers and electrical powers, can be compared.

4. It is based on a simple relation.

5. It is approximately equal, in the effect on volume, to the "mile of standard cable."

6. It is convenient for computation.

Powers are commonly measured in telephony by measuring the current (or voltage), in an impedance which is known or can be measured, so that the current and voltage relations at various points are usually known. In cases where the currents associated with the powers are proportional to the square root of the powers

$$N_{TU} = 20 \log \frac{I_1}{I_2}$$

where

$$\frac{I_1}{I_2}$$

is the current ratio.

A table of some common ratios and the number of transmission units corresponding is appended:

TRANSMISSION UNITS	APPROXIMATE POWER RATIOS	
	For Loss	For Gain
1	.8	1.25
2	.63	1.6
3	.5	2.
4	.4	2.5
5	.32	3.2
6	.25	4.
7	.2	5.
8	.16	6.
9	.125	8.
10	.1	10.
20	.01	100.
30	.001	1000.
40	.0001	10000.
50	.00001	100000.
60	.000001	1000000.

—P. A. BURNS

Condensers and Heat

Too little thought is given to the matter of temperature in the handling of condensers. Condensers, when placed in "B" power-packs, should not be exposed to high temperature from the radiated heat of rectifier valves or resistors in their immediate vicinity. The condensers should be protected from heat by proper spacing or by partitions, if necessary, and the valves and resistors should be provided with proper ventilation. In any case, paper condensers should not be heated beyond 110 deg. F.

Tests recently conducted serve to throw considerable light on this matter of heat in the performance of condensers. In a direct comparison between

condensers heated to normal room temperature and condensers heated to 125 deg. F., over a period of eighteen hours, so as to make certain that the condensers were heated throughout their mass and not just externally, the condensers heated to the higher temperature withstood a 20 per cent higher breakdown voltage.

This might seem contrary to expectations and would indicate, on its face, that condensers were benefitted by heating. However, such performance is no indication of life, and subsequent life tests have shown that a condenser heated above room temperature has its life shortened materially.

—HARRY F. HOUCK

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ABOVE — $\frac{2}{3}$ Actual Size
BELOW — $\frac{1}{2}$ Actual Size

- 1 Durham Resistors—500 Ohms to 10 Megohms; standard brass end tip, mould or pigtail type.
- 2 Durham Grid Suppressors—250 Ohms to 3000 Ohms in steps of 100; standard brass end tip.
- 3 Durham Powerohm—1 Watt; 250 to 1,000,000 Ohms; standard brass end tip or pigtail type.
- 4 Durham Powerohm— $2\frac{1}{2}$ Watts; 500 to 250,000 Ohms; standard brass end tip type.
- 5 Durham Powerohm— $2\frac{1}{2}$ Watts; 500 to 250,000 Ohms; knife-end type.
- 6 Durham Powerohm— $2\frac{1}{2}$ Watts; 500 to 250,000 Ohms; soldered end tapped type.
- 7 Durham Powerohm— $2\frac{1}{2}$ Watts; 500 to 250,000 Ohms; screw-end type.
- 8 Durham Powerohm—5 Watts; 250 to 250,000 Ohms; soldered end tapped or screw-end type.
- 9 Durham Powerohm—10 Watts; 250 to 250,000 Ohms; soldered end tapped and screw-end type.
- 10 Durham Powerohm—25 Watts; 250 to 250,000 Ohms; soldered and tapped.
- 11 Durham Powerohm—50 Watts; 250 to 250,000 Ohms; soldered and tapped.
- 12 Durham Mounting supplied in various lengths to carry any required number of Powerohms where quick change of resistance is necessary.

INTERNATIONAL RESISTANCE COMPANY

2½ South 20th Street, Philadelphia, Pa.

DURHAM
METALLIZED
**RESISTORS
& POWEROHMS**

30

Popular Radio

and TELEVISION

MAY • 1928★

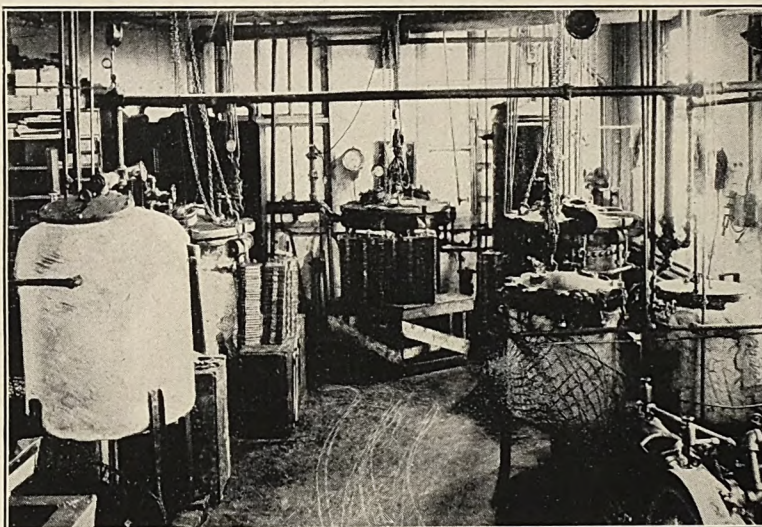
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05

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**How to Make Television
Apparatus at Home**



A corner of the impregnating room of the Aerovox Wireless Corporation.

Concentrated Effort !

IN specializing on and perfecting condensers and resistors which have stood up under every test made to determine their worth, the Aerovox Wireless Corporation has attained a goal made possible only by perfect co-ordination, co-operation, and concentration of every element in an organization devoted exclusively to the production of high quality condensers and resistors.

The Aerovox "Research Worker" is devoted to the dissemination of interesting and useful technical data. Send for copy.

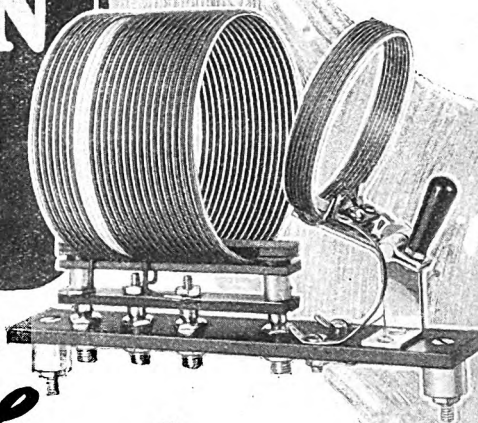


Aerovox Filter Condensers are made in single units and combination blocks to meet every socket power need.

AEROVOX

"Built Better"
70 Washington St., Brooklyn, N. Y.

The Perfected PLUG-IN COIL



It's the Hammarlund!

FOR several seasons Hammarlund low-loss, space-wound coils, have been universally approved by those who "know their stuff" in radio.

Now they may be had in the convenient plug-in form—a set of three coils efficiently covering the low-wave bands from 20 to 80 meters. Also special coils for higher wavelengths.

Contacts are perfect. The double silk covered wire is space-wound and firmly anchored in a film of high-test dielectric material. Losses are low. Short-circuits are impossible.

The variable primary coil has phosphor-bronze spring connections and is integral with the Bakelite base. Friction holds it at any desired coupling.

*If your dealer can't supply you,
write direct to us*

HAMMARLUND MANUFACTURING COMPANY
424-438 West 33rd Street, New York

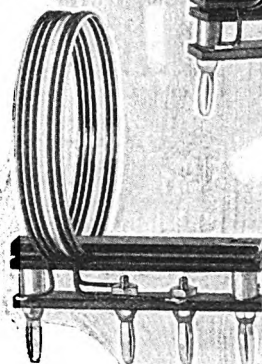
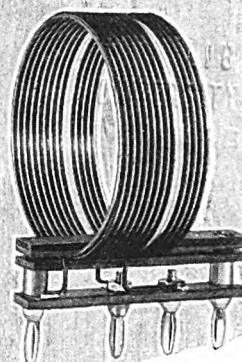
FOR LOW-WAVE RECEPTION

(20, 40 and 80 Meter Bands)
Three Coils and Plug-in Base
\$10.00 complete.

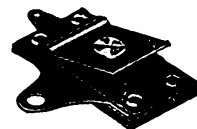
Coils.....\$2.50 each

Base..... 3.00 each

Write for Special Folder



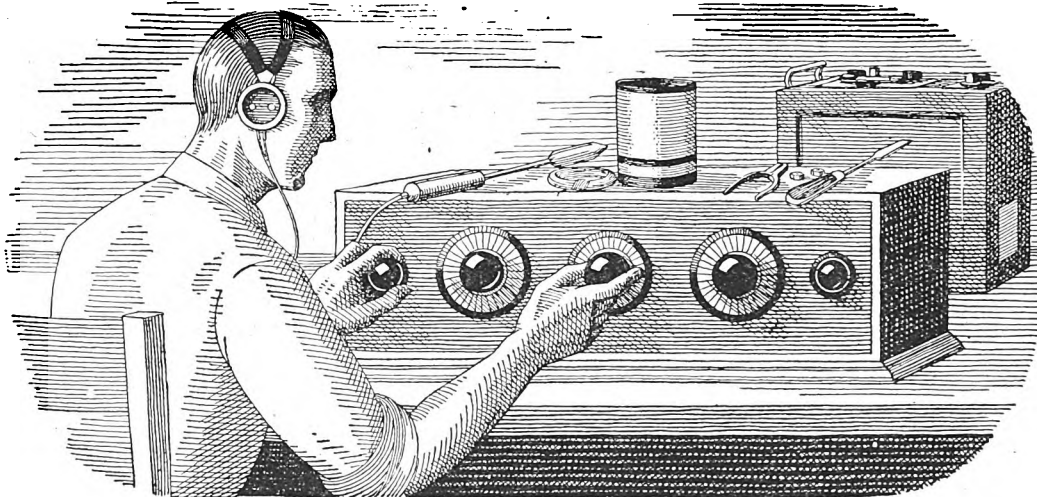
The New HAMMARLUND Equalizing Condenser



Greatly improved and simplified. Mica dielectric and flexible phosphor-bronze spring plate, firmly riveted to Bakelite base. Cannot short-circuit. Compact—fits small space. Direct attachment.

For Better Radio
Hammarlund
PRECISION
PRODUCTS





If all the Radio sets I've "fooled" with in my time were piled on top of each other, they'd reach about halfway to Mars. The trouble with me was that I thought I knew so much about Radio that I really didn't know the first thing. I thought Radio was a plaything—that was all I could see in it for me.

I Thought Radio Was a Plaything

*But Now My Eyes Are Opened, And
I'm Making Over \$100 a Week!*

\$50 a week! Man alive, just one year ago a salary that big would have been the height of my ambition.

Twelve months ago I was scrimping along on starvation wages, just barely making both ends meet. It was the same old story—a little job, a salary just as small as the job—while I myself had been dragging along in the rut so long I couldn't see over the sides.

If you'd told me a year ago that in twelve months' time I would be making \$100 and more every week in the Radio business—whew! I know I'd have thought you were crazy. But that's the sort of money I'm pulling down right now—and in the future I expect even more. Why only today—

But I'm getting ahead of my story. I was hard up a year ago because I was kidding myself, that's all—not because I had to be. I could have been holding then the same sort of job I'm holding now, if I'd only been wise to myself. If you've fooled around with Radio, but never thought of it as a serious business, maybe you're in just the same boat I was. If so, you'll want to read how my eyes were opened for me.

When broadcasting first became the rage, several years ago, I first began my dabbling with the new art of Radio. I was "nuts" about the subject, like many thousands of other fellows all over the country. And no wonder! There's a fascination—something that grabs hold of a fellow—about twirling a little knob and suddenly listening to a voice speaking a thousand miles away! Twirling it a little more and listening to the mysterious dots and dashes of steamers far at sea. Even today I get a thrill from this strange force. In those days, many times I stayed up almost the whole night trying for DX. Many times I missed supper because I couldn't be dragged away from the latest circuit I was trying out.

I never seemed to get very far with it, though. I used to read the Radio magazines and occasionally a Radio book, but I never understood the subject very clearly, and lots of things I didn't see through at all.

So, up to a year ago, I was just a dabbler—I thought Radio was a plaything. I never realized what an enormous, fast-growing industry Radio had come to be—employing thousands and thousands of trained men. I

usually stayed home in the evenings after work, because I didn't make enough money to go out very much. And generally during the evening I'd tinker a little with Radio—a set of my own or some friend's. I even made a little spare change this way, which helped a lot, but I didn't know enough to go very far with such work.

And as for the idea that a splendid Radio job might be mine, if I made a little effort to prepare for it—such an idea never entered my mind. When a friend suggested it to me one year ago, I laughed at him.

"You're kidding me," I said.

"I'm not," he replied. "Take a look at this ad."

He pointed to a page ad in a magazine, an advertisement I'd seen many times but just passed up without thinking, never dreaming it applied to me. This time I read the ad carefully. It told of many big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. Well, it was a revelation to me. I read the book carefully, and when I finished it I made my decision.

What's happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months I've had a Radio business of my own. At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that

day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

Now I'm making, as I told you before, over \$100 a week. And I know the future holds even more, for Radio is one of the most progressive, fastest-growing businesses in the world today. And it's work that I like—work a man can get interested in.

Here's a real tip. You may not be as bad off as I was. But think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years—making the same money? If not, you'd better be doing something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you inexpensively in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

Take another tip—No matter what your plans are, no matter how much or how little you know about Radio—clip the coupon below and look their free book over. It is filled with interesting facts, figures, and photos, and the information it will give you is worth a few minutes of anybody's time. You will place yourself under no obligation—the book is free, and is gladly sent to anyone who wants to know about Radio. Just address J. E. Smith, President National Radio Institute, Dept. 5K, Washington, D. C.

**J. E. SMITH, President,
National Radio Institute,
Dept. 5K, Washington, D. C.**

Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving all information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesman will call on me.

Name

Address

Town State



AmerTran DeLuxe Audio Transformer, Standard of Excellence 1st Stage; Turn Radio, 3: 2nd Stage; Turn Radio, 4: Price, each \$10.00.

AMERTRAN
TRADE MARK REG. U.S. PAT. OFF.

Quality Radio Products

Standards of Excellence for Radio Reproduction

THE real worth of any radio set depends upon "tone quality"—the ability to reproduce music as it is broadcast from the studio. The problem has never been one of refining the radio frequency amplifier—it has always been the manufacturers of audio systems who have had to develop their products to reach the pinnacle of natural reproduction.

Long before broadcasting was thought of, The American Transformer Company had gained a reputation of manufacturing quality products. Since the era of broadcasting, this company has occupied a unique position in the development of quality products for Radio Reproduction. AmerTran products have been considered too expensive for set manufacturers to use in their commercial receivers, so it has developed a clientele of set builders who want, first of all, *natural reproduction*.

AmerTran products are never built down to a price—the procedure has always been reversed—"How good can it be made—then reduce the cost by applying economies in manufacture."

The products shown on this page are but a few of the thirty odd AmerTran devices in the field of radio reproduction, each of which has attained the degree of perfection necessary to be introduced as an AmerTran product. The facilities of our engineering department are at the service of every one interested in better radio reproduction. We will answer to the best of our ability any question in the audio or power fields.

AMERICAN TRANSFORMER COMPANY
Transformer Builders for more than 28 years
111 EMMET ST. NEWARK, N. J.

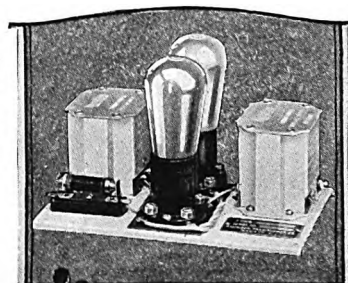


AmerTran Push-Pull Amplifier—complete 2 stage audio amplifier. First stage AmerTran DeLuxe and second stage AmerTran Push-Pull for two Power Tubes. Choice of standard amplifier or UX 227 AC for 1st stage and two 171 or two 210 power tubes for second stage. Price, east of Rockies—less tubes—\$60.00.

AmerTran ABC Hi-Power Box—500 volts DC plate voltage, current up to 110 ma; AC filament current for rectifier, power tubes and sufficient 216 and 227 AC Tubes for any set. Adjustable bias voltages for all tubes. Price, east of Rockies—less tubes—\$35.00.



AmerTran Push-Pull Power Stage (illustrated below)—completely wired with input transformer and a choice of 4 output transformers depending on speaker and power tubes. Adaptable to 171 or 210 tubes, cones or dynamic type speakers. Price, east of Rockies—less tubes—\$36.00.



Push-Pull Amplifier, ABC Hi-Power Box and Push-Pull Power Stage licensed under patents owned or controlled by RCA and may be bought complete with tubes.

ABSOLUTE TONE FIDELITY

No Substitute for Dynamic Cone Performance

NO MATTER what speaker you own...or how much you paid for it.. you will very soon agree with us that there can be no substitute for Dynamic Cone Performance.

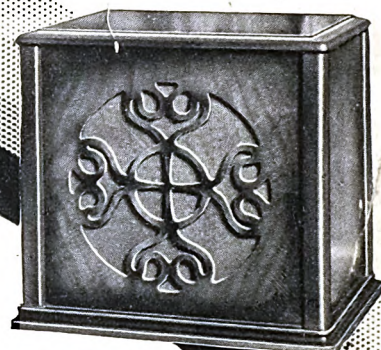
New as a practical application of a proven principle..the Jensen Dynamic Speaker sets unsurpassed standards of tone reproduction.

From the deepest bass to the highest treble ..(20 to 6000 cycles) this speaker reflects the whole sound range without distortion and with lifelike fidelity. To hear the Jensen Speaker is to understand the Jensen claim

...*"The Finest in Radio"*

Write for our two-color folder which completely describes and illustrates the various types of speakers.

JENSEN RADIO MFG. CO.
212 Ninth Street 35 East Wacker Drive
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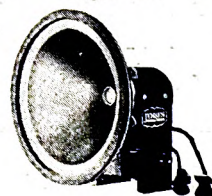
Cabinet Models

- TYPE D-44 . . . \$65.00
For 6 volts operation
- TYPE D-45 . . . \$67.50
For 90 volts operation
- TYPE D-44 A.C. . . \$75.00
For 110 volts A.C. operation
Height 14". Width 16".
Depth 12".



Console Model

- TYPE D-54 A.C. . . \$90.00
Height 34½". Width 14¼".
Depth 11".



Jensen Dynamic Units

- TYPE D-4 . . . \$47.50
For 6 volts operation
- TYPE D-5 . . . \$50.00
For 90 volts operation
- TYPE D-4 A.C. . . \$57.50
For 110 volts A.C. operation
Height 10¾". Width 10".
Depth 8½".

JENSEN

DYNAMIC SPEAKER

The Finest in Radio

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